PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2001-060394
(43)Date of publication of application : 06.03.2001

)Int.CI.
G11C 13/04
G02B 5/32
G03H 1/04
G03H 1/22
// G11B 7/0065

)Application number : 2000-130591
)Date of filing : 28.04.2000

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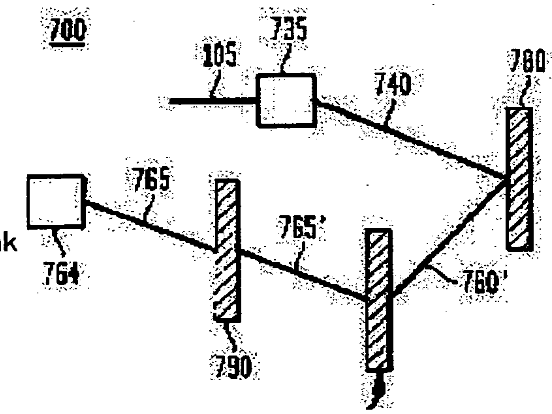
)Priority
ority number : 99 304031 Priority date : 03.05.1999 Priority country : US

) PHASE CORRELATION MULTIPLEXED(PCM) HOLOGRAPHIC MEMORY SYSTEM

)Abstract:
OBLEM TO BE SOLVED: To realize speedier location and retrieval of ographically stored data by allocating a beam in a limited bandwidth 'ore a holographic element storing a hologram of a reference beam is ıdiated with the beam by using a filter like an aperture.
LUTION: A spatial spectrum of a reference beam is controlled by ənting a beam through a filter 790 for covering a part of a reference ım in order to eliminate high frequency components from the reference ım. The filter 790 controls a plane wave signal 765, and thereby a half ue full width of an altered plane wave signal 765' is largely increased. ərefore, the bandwidth of the reference beam is expanded while the peak sition is kept as it is. And, to ascertain the position of the prescribed ographic data, a necessary scanning resolution is largely degraded, and ı holographic data position can be ascertained more speedily.



ıAL STATUS
ate of request for examination] 13.08.2002
ate of sending the examiner's decision of rejection]
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OTICES *

AIMS

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aim(s)]
aim 1] (a) The holographic memory cell which memorizes holographic data and it has inside (HMC), (b) The ographic optical element which memorizes the hologram of the holographic memory system (HMS) reference beam ch has predetermined frequency spectrum, and it has inside (HOE), (c) The source of an object beam which erates an object beam and turns said object beam to said holographic memory cell, (d) The source of a plane wave ch generates a plane wave signal and turns said plane wave signal to said HOE, (e) when it has been arranged ween said source of a plane wave, and said HOE, it consists of a filter which operates said plane wave signal and said E is irradiated by said operated plane wave signal Said HOE is a phase correlation multiplexing (PCM) holographic nory system characterized by what a modification HMS reference beam is turned and projected for on said ographic memory cell.
aim 2] Said filter is a system according to claim 1 characterized by what said a part of plane wave signal is covered

aim 3] Said filter is a system according to claim 2 characterized by what the high-frequency component of said plane re signal is removed for.
aim 4] Said filter is a system according to claim 2 characterized by what it consists of opening of fixed area and is e for the orientation of said plane wave signal through this opening.
aim 5] Said filter is a system according to claim 2 characterized by what it consists of opening of adjustable area and one for the orientation of said plane wave signal through this opening.
aim 6] Said source of an object beam is a system according to claim 1 characterized by what it consists of (b) laser a (b) optical processor, and orientation of said laser is carried out through this optical processor, and said object m appears from this optical processor.
aim 7] Said HOE is a system according to claim 1 characterized by what is been the transparent mode HOE.
aim 8] Said HOE is a system according to claim 1 characterized by what is been in reflective mode HOE.
aim 9] The holographic memory cell which memorizes holographic data and it has inside (HMC), The holographic ical element which memorizes the hologram of a HMS reference beam and it has inside (HOE), The source of an ect beam which generates an object beam and turns said object beam to said holographic memory cell, It is the roach of controlling the selectivity of the holographic memory system (HMS) which has the source of a plane wave ch generates a plane wave signal and turns said plane wave signal to said HOE. This approach When said HOE is minated by the operated plane wave signal, in order that said HOE may turn and project a modification HMS rence beam on said holographic memory cell The selectivity control approach of the holographic memory system MS) characterized by what is consisted of a step which operates said plane wave signal.
aim 10] The approach according to claim 9 characterized by what it has further the step which covers said a part of ne wave signal for.
aim 11] The approach according to claim 9 characterized by what it has further the step which removes the high-quency component of said plane wave signal for.
aim 12] The approach according to claim 9 characterized by what it has further for the step which carries out ntation of said plane wave signal through opening of fixed area.
aim 13] The approach according to claim 9 characterized by what it has further for the step which carries out ntation of said plane wave signal through opening of adjustable area.
aim 14] The holographic storage ingredient which has two or more holographic data memorized inside memorizes. It ne approach of tracing the holographic data storage location used with the holographic memory system possessing holographic optical element (HOE) which memorizes and has the hologram of a holographic memory system (HMS) de. And this approach (a) the step which turns an object beam to said holographic storage ingredient, and when said

E is illuminated by the plane wave signal by which (b) actuation was carried out The holographic data storage ıtion **** approach characterized by what is consisted of a step which operates said plane wave signal turned to said E in order that said HOE may turn and project a modification HMS reference beam on said holographic storage ·edient.

ıim 15] Said step (b) is an approach according to claim 14 characterized by what is consisted of covering said a part ılane wave signal.

ıim 16] Said step (b) is an approach according to claim 14 characterized by what is consisted of removing the high-ıuency component of said plane wave signal.

ıim 17] Said step (b) is an approach according to claim 14 characterized by what is consisted of carrying out ntation of said plane wave signal through opening of fixed area.

ıim 18] Said step (b) is an approach according to claim 14 characterized by what is consisted of carrying out ntation of said plane wave signal through opening of adjustable area.

ıim 19] It is the system with which the holographic data storage location memorized in the holographic storage ·edient is traced and searched. This system (a) The holographic optical element which memorizes the hologram of a S reference beam and it has inside (HOE), (b) The light source which generates the lightwave signal by which the imation was carried out in general, and turns said lightwave signal to said HOE, (c) when it has been arranged veen said light source and said HOE, it consists of a filter which operates said lightwave signal and said HOE is diated by said operated lightwave signal Said HOE is holographic data storage location **** and a retrieval system racterized by what a modification reference beam is turned and projected for on said holographic storage ingredient.

ıim 20] Said filter is a system according to claim 19 characterized by what said a part of lightwave signal is covered

ıim 21] Said filter is a system according to claim 20 characterized by what the high-frequency component of said twave signal is removed for.

ıim 22] Said filter is a system according to claim 20 characterized by what it consists of opening of fixed area and is e for the orientation of said lightwave signal through this opening.

ıim 23] Said filter is a system according to claim 20 characterized by what it consists of opening of adjustable area is done for the orientation of said lightwave signal through this opening.

ınslation done.]

OTICES *

TAILED DESCRIPTION

tailed Description of the Invention]
)01]
:ld of the Invention] This invention relates to a holographic memory system. Furthermore, this invention relates to system and approach of controlling the selectivity of a holographic memory system at a detail.
)02]
scription of the Prior Art] Holographic memory or a storage system needs three-dimensions storage of a holographic ›lay of a data element (namely, hologram) as the refractive index stamped in the capacity of a storage like the crystal ithium niobate, and/or a change pattern of absorption. A holographic memory system (HMS) is characterized by the ential rate which accesses the high density storage potentia and stored data at random, and is changed into them.
)03] Generally, a data coding object beam is combined with a phase coherent reference beam, and it operates by erating an interference pattern from the corner of a photosensitive storage like a holographic memory cell (HMC) to ›rner. An interference pattern induces the ingredient denaturation in HMC which records a hologram. The response he hologram in a storage is the function of the relative amplitude of an object beam and a reference beam, and the se contrast of an object beam and a reference beam. Moreover, it depends for this response on the include angle en being projected on the wavelength, object beam, and reference beam of an incident beam to a storage sharply.
)04] The data memorized in holography are reproduced by projecting a reference beam similar to the reference beam d for memorizing data to HMC in the same include angle used for generating a hologram, wavelength, a phase, and a ıtion. A hologram and a reference beam interact and reproduce the memorized object beam (namely, data). Then, the :oduced object beam is detected for example, using a photo detector array. Subsequently, in order to transmit to an)ut device, corrective action of the recovery data is carried out.
)05] Generally, the dynamic range of a holographic storage is larger than the dynamic range required to memorize the gle hologram which has the signal-to-noise (S/N) ratio which can be admitted. Therefore, in order to attain much :e big recording density, it is desirable to multiplex the hologram of a large number in a certain location in a storage. : of the redundancy technics is phase correlation multiplexing (PCM). With this technique, in order to identify the ·lication hologram in a storage, correlation selectivity and the Bragg (Bragg) selectivity are used. Correlation :ctivity is based on the amplitude, the phase, and the contents of an include angle of the reference beam generated by relative shift (the direction of arbitration) of the storage about the reference beam.
)06] However, a multiplex system like PCM needs a comparatively complicated reference beam. A complicated se mask, a high quality lens, and the fourier flat-surface spatial filtering are required for generation of this reference m. Unluckily, the structure of a phase mask is delicate and a lens is about [being expensive] and bulky. Moreover, fourier phase space filter blocks the great portion of incident light energy, and increases output supply of a system rply. Moreover, it is necessary to perform alignment of these components in the level precision below a micron crometer), and, in the case of a PCM holographic memory system, still more generally, it must be adjusted for every :em. Though level of such adjustment cannot be carried out using components and a technique in ordinary use, it is y difficult. In order to generate or reproduce the reference beam for holographic memory systems, a holographic ical element (HOE) can be used. Therefore, generally HOE brings about the adjustment arrangement in which ıparatively cheap and easy reappearance of one or more required optical elements is possible, in order to generate the :rence beam in HMS. An example of HOE is indicated by the United States patent application/[08th] No. 968,024 cification.
)07] When using PCM in a holographic memory system, or other correlation selectivity techniques, creation ›rmation memorized by HMC is characterized by comparatively high resolution, therefore high selectivity. High ›lution and high selectivity are desirable properties, and high resolution and a high selectivity technique, and

ıpment are required also for retrieval of the holographic data moreover memorized although it was just required for ı density record of the hologram by HMC.
)8]
ıblem(s) to be Solved by the Invention] Therefore, the purpose of this invention is increasing the width of face of the ctivity function of the memorized hologram, searching still more quickly the holographic data memorized by that ;e, and offering the capacity to search.
)9]
:ans for Solving the Problem] Said technical problem is solved by the control system and approach of a selectivity :tion in a holographic memory system which enable still quicker location (the storage location tracing) and retrieval ıe data memorized in holograph. According to this invention, a beam is assigned to limit bandwidth before liating the holographic optical element the hologram of a reference beam was remembered to be for the beam with a r like opening in the reference beam.
l0] This invention offers a phase correlation multiplexing (PCM) holographic memory system (HMS). This PCM udes the holographic memory cell (HMC) which has holographic data memorized in this. Moreover, a PCM ›graphic memory system also has the holographic optical element (HOE) the hologram of the HMS reference beam ch has predetermined frequency spectrum was remembered to be. An object beam is generated and the source of an :ct beam for turning this object beam to a holographic memory cell is arranged. A plane wave signal is generated and source of a plane wave for turning this plane wave signal to HOE is also arranged. Moreover, the PCM holographic nory system of this invention also has a filter (arranged between the source of a plane wave, and HOE) for operating ane wave optical field. If HOE is irradiated by the operated plane wave signal, HOE will project a modification 'S reference beam toward a holographic memory cell.
l1] This invention also offers the approach of controlling the selectivity of the holographic memory system (HMS) ch has the holographic memory cell (HMC) holographic data were remembered to be. This HMS also includes the ›graphic optical element (HOE) the hologram of a HMS reference beam was remembered to be, the source of an :ct beam for generating an object beam and turning this object beam to a holographic memory cell, and the source of ane wave for generating a plane wave signal and turning this plane wave signal to HOE. When this control approach sists of a step which operates a plane wave signal and HOE is irradiated by the operated plane wave signal, HOE .s and projects a modification HMS reference beam on a holographic memory cell.
l2] Furthermore, this invention also offers the approach of tracing the holographic data storage location memorized ıe holographic storage ingredient which has two or more holographic data used with the holographic memory system /IS) which has the holographic optical element (HOE) the hologram of a HMS reference beam was remembered to The approach of this embodiment consists of turning an object beam to a holographic storage ingredient. This roach also has the step which operates further the plane wave signal turned to HOE. When HOE is irradiated by the rated plane wave signal by this, HOE turns and projects a modification HMS reference beam on a holographic age ingredient.
l3] Furthermore, this invention traces the holographic data storage location memorized in the holographic storage 'edient, and also offers the system to search. The system of this embodiment has the holographic optical element)E) the hologram of a reference beam was remembered to be. This system generates the lightwave signal by which collimation was carried out further in general, and also has the light source for turning this lightwave signal to HOE. :eover, this system also has the filter arranged between the light sources and HOE(s) for operating a lightwave ıal. If HOE is irradiated with the operated lightwave signal, HOE will turn and project a modification reference beam ı holographic storage ingredient.
l4]
ıbodiment of the Invention] An example of the technique which multiplexes many holograms in order to obtain the ı recording density in a holographic storage ingredient is phase correlation multiplexing (PCM). Phase correlation tiplexing is indicated by the U.S. Pat. No. 5719691 official report.
l5] Vocabulary called the "holographic medium" or the "holographic storage ingredient" used on these specifications ıns the ingredient which has the photochemistry operation which can record a hologram on the interior. This 'edient can take various gestalten of the film containing for example, a distributed silver halogenide particle, an /late system phot polymer, or self-standing LiNbO3 crystal.
l6] The vocabulary "a holographic optical element (HOE)" used on these specifications means the dioptrics object in ch one or more holograms of the reference beam used within a holographic memory system (HMS) can be shown. E can be made to ** generation, generating, formation, etc. by interference in the holographic storage ingredient veen a plane wave signal (namely, HOE reference beam) and an object beam (namely, HMS reference beam). HOE

consist of ingredients of suitable arbitration to record a hologram. If HOE is generated, a HMS reference beam can eproduced by turning to HOE the plane wave (namely, lightwave signal by which the collimation was carried out in eral) which has the same property as a HOE reference beam. Therefore, a playback reference beam offers a means to erate a HMS reference beam, without needing an optical processor. Therefore, HOE offers the single optical element ch generates the reference beam replaced with an optical processor, and simplifies the approach of making a rence beam generating in a holographic memory system.

17] Vocabulary called the "selectivity" and the "selectivity function" which are used on these specifications means capacity of a holographic memory system (or that alien system that records and/or searches holographic data ormation)) for identifying two or more holographic data (or holographic information) memorized in the holographic age ingredient. The selectivity of a holographic memory system changes according to the bandwidth of the reference ı used in order that at least a part may record and search holographic data (information).

18] Drawing 1 shows the typical optical processor 135 used with a phase correlation multiplexing (PCM) ographic memory system (HMS). The optical processor 135 changes the plane wave signal 105 into a coding beam. oding beam can be used as a reference beam for HMS (namely, HMS reference beam). Furthermore, specifically, the ıe wave signal 105 (namely, coherent beam of a laser beam) irradiates the high precision reference mask 110 (for mple, a phase mask and/or an amplitude mask). A mask 110 encodes a light beam 105 by guiding the bandwidth duct between altitude of for example, a plane wave signal. A coding beam spreads even the 1st lens 115 which has a ıl distance f1 only for distance f1. Passage of the 1st lens 115 generates the Fourier transform object of the reference se mask 110 at the point of another distance f1 over the 1st lens 115. The highpass spatial filter 120 is formed in the d location of a Fourier transform object. Generally a filter 120 blocks most frequencies between low altitudes tted from the reference mask 110. After passing a high-pass filter 120, a coding beam spreads even the 2nd lens 125 ch has a focal distance f2 only for distance f2. A coding beam passes the 2nd lens 125, spreads only another distance and arrives at the image surface 130. In the image surface 130, the coding beam 140 (Sign A is attached) can be racterized as a reference beam (namely, HMS reference beam) of a holographic memory system (HMS).

19] The hologram (namely, hologram of a HMS reference beam) of the coding beam 140 can be made to memorize holographic medium (to refer to drawing 2 and drawing 3) by arranging a holographic medium in the location of image surface 130.

20] Vocabulary called the "reference beam" and the "object beam" which are used on these specifications means the m used with the beam and holographic memory system which are used in order to generate HOE, respectively. refore, in order to distinguish and use these vocabulary, "HOE" and "HMS" are attached and distinguished suitably.

21] Drawing 2 shows the generation or formation of the holographic optical element (HOE) 250 used with the ographic memory system by this invention. Especially drawing 2 shows generation of the transparent mode HOE250. n A was attached) The HOE object beam 240 (it is also a HMS reference beam) is generated as explained in relation rawing 1 . The HOE object beam 240 spreads only distance D from the optical processor 235 toward the holographic age ingredient 252, or orientation is carried out by the option. Incidence of the HOE object beam 240 is carried out he holographic storage ingredient 252, and it intersects the HOE reference beam 260 (plane wave signal) there. The E reference beam 260 is as coherent as the HOE object beam 240. It is generated according to the light source 264, the HOE reference beam 260 is turned to the holographic storage ingredient 252 from this light source, and minates the holographic storage ingredient 252, and intersects the HOE object beam 240 by the position in the ographic storage ingredient 252. The interference pattern generated between the HOE object beam 240 and the HOE rence beam 260 is recorded as a hologram within the holographic storage ingredient 252. Therefore, the holographic age ingredient 252 is changed into the holographic optical element (HOE) 250 which has the hologram of the HOE ect beam 240 (namely, HMS reference beam) memorized inside.

22] although the HOE reference beam 260 can be a beam of suitable arbitration -- general -- a plane wave -- or it is beam of refreshable others easily. Generally the HOE object beam 240 and the HOE reference beam 260 are erated by this contractor by the coherent light from a well-known the same or similar laser light source.

23] The holographic storage ingredient 252 can also be an ingredient of suitable arbitration, or can also be the figuration or arrangement of an ingredient which can record any of a surface hologram or a volume hologram they and can generate diffraction enantiomer. For example, the holographic storage ingredient 252 is a phot polymer, a toresist, thermoplastics, a refractility ingredient, or an optical compatible ingredient. The holographic storage edient 252 has the 1st field 265 of general in general a plane, and the 2nd field 270 where a plane counters in eral. It is fully a plane, or the holographic storage ingredient 252 hits 1cm, and is refreshable to two waves of light in eral.

24] Drawing 3 shows the generation or formation of the reflective mode holographic optical element (HOE) 350

d with the holographic memory system by this invention. HOE350 shown in drawing 3 is shown in drawing 2 , and a different configuration from the transparent mode HOE250 explained above. Furthermore, specifically, it is erated from the light source 364, (Beam B) is turned to the 2nd field of the holographic storage ingredient 352, and HOE reference beam 360 intersects a HOE object beam (beam A) by the position in the holographic storage edient 352. The generated interference pattern is caught as a hologram of the HOE object beam 340 within the graphic storage ingredient 352, and HOE350 of the HOE object beam 340 is formed thus. The reflective mode E350 differs from the transparent mode HOE250 the following point. Although the reflective mode HOE350 is erated using the beam turned to the opposite side of the holographic storage ingredient 352, the transparent mode E250 is generated using the beam turned to the same field of the holographic storage ingredient 252.

25] Both the transparent mode and a reflective mode holographic optical element (HOE) can memorize two or more E object beams in this optical element by multiplexing. For example, when a holographic storage ingredient is nparatively thick (for example, 1mm), two or more HOE object beams can be made to be able to multiplex within a graphic storage ingredient, and can form HOE of two or more object beams. Multiplexing of two or more object ms can be performed by changing the include angle, the wavelength, or the location of a HOE reference beam, nging an object beam property. Change of an object beam property can be carried out by, for example, using a mask, fferent filter, or a different lens combination configuration.

26] Drawing 4 A and drawing 4 B show the transparent mode holographic optical element (HOE) 550 used with the graphic memory system (HMS) 500 constituted by this invention. the reference beam used in order to reproduce the E object beam 540 (beam A) from HOE550, and to generate HOE550 -- it is generated from the light source 564, the same or similar reference beam 560 is turned to HOE550, and illuminates HOE550. The beam emitted from E550 in the case of lighting is playback of the HOE object beam 540 (beam A). This is an object beam caught from first with the holographic storage ingredient 552, in order to generate HOE550, and it shows a HMS reference beam. contents and the direction of the reference beam 560 to HOE550 change partially according to the distance D ween the 2nd lens 525 in the optical processor 535 (refer to drawing 2), and the holographic storage ingredient 252 npared with the focal distance f2 of the 2nd lens during generation of the holographic optical element 550 (for mple, optical element which is shown in drawing 2 and explained above) at least.

27] As shown in drawing 4 A, when the distance D under HOE550 generation is under the focal distance f2 (refer to wing 2) of the 2nd lens, the image surface 575 (Sign P is attached) of the HOE object beam 540 is formed exceeding E550. In such a case, HOE550 is illuminated like the case where it is used in order to generate HOE550, by turning a rence beam 560 to the same field (namely, field 565). Then, the HOE object beam 540 is reproduced by the raction of a reference beam 560 and HOE550, and the image surface 575 (or other desired fields) of the HOE object m 540 is formed exceeding HOE550.

28] As shown in drawing 4 B, when the distance D under HOE550 generation is larger than the focal distance f2 er to drawing 2) of the 2nd lens, the image surface 575 (Sign P is attached) of the HOE object beam 540 is formed nis side or a transverse plane rather than HOE550. In such a case, HOE550 is illuminated from the same opposite as what used the compound conjugate one of the reference beam 562 generated from the light source 563, and was d in order to generate the 2nd field 550, i.e., HOE. Compound conjugation (sign A* is attached) of the HOE rence beam 542 is reproduced by the interaction of the compound conjugate one of a reference beam 562, and E550, and the field 575 of a request of compound conjugation (sign A* is attached) of the HOE object beam 542 is ned in this side or transverse plane of HOE550.

29] In both embodiments shown in drawing 4 A and drawing 4 B, the holographic memory system 500 has the graphic memory cell (HMC) 580 which can memorize two or more holographic data. HMC580 is arranged in tion to the image surface 575 the location of the holographic data of the arbitration memorized in this, and for ieval. Holographic data are memorized in HMC580 as an array constituted by the comparatively close **** high sity characterized with the high selectivity between [each] two or more holographic data. For example, the rding density in a PCM holographic memory system is [micrometer] 2 about 300 channels a bit /.

30] Drawing 5 A and drawing 5 B show the reflective mode holographic optical element (HOE) 650 as some graphic memory systems 600 constituted by this invention. The playback reference beam 660 from the light source is turned to HOE650, and the HOE object beam 640 (beam A) irradiates it, and is reproduced by illuminating E650. The contents and the direction of the playback reference beam 660 (beam B) to HOE650 change partially ording to the distance D between the 2nd lens 625 (for example, refer to drawing 3) of the optical processor 635, the holographic storage ingredient 652 compared with the focal distance f2 of the 2nd lens under generation of E650 at least.

31] As shown in drawing 5 A, when the distance D under generation of HOE650 is less than [of the 2nd lens / focal

ance f2], the image surface 675 (Sign P is attached) of the HOE object beam 640 is formed exceeding HOE650. In ı a case, HOE650 is illuminated by turning a reference beam 660 to the 2nd field 670. Then, the same with having lained above, the interaction of a reference beam 660 and HOE650 is reproduced, and the HOE object beam 640 ns the image surface 675 (or other desired fields) of the HOE object beam 640 in the location beyond HOE650.
32] As shown in drawing 5 B, when the distance D under generation of HOE650 is larger than the focal distance f2 he 2nd lens, the image surface 675 (Sign P is attached) of compound conjugation (sign A* is attached) of the HOE ect beam 642 is formed a transverse plane or before the holographic optical element (HOE) 650. In such a case, E650 is illuminated by the compound conjugate one of the reference beam 662 generated from the light source 663. compound conjugate one of a reference beam 662 illuminates HOE650 from the 1st field 665 of what was used in er to generate HOE650, and the opposite side. The interaction of the compound conjugate one of a reference beam and HOE650 is reproduced, and compound conjugation (sign A* is attached) of the HOE object beam 642 forms image surface 675 of compound conjugation (sign A* is attached) of the HOE object beam 642, or the field of other ıests in this side or transverse plane of HOE650.
33] In both embodiments shown in drawing 5 A and drawing 5 B, the holographic memory system 600 has the graphic memory cell (HMC) 680 which can memorize two or more holographic data. HMC680 is arranged in tion to ROKEYON of the holographic data of the arbitration memorized in this, and the image surface 675 for ieval. Holographic data are memorized in HMC680 as an array constituted by the comparatively close **** high sity characterized with the high selectivity between [each] the holographic data with which plurality is memorized.
34] Generally drawing 4 A, drawing 4 B, drawing 5 A, and drawing 5 B show the system and approach of recording toring holographic data in a holographic storage with a high density gestalt. Next, drawing 6 is referred to. The ıtion and retrieval of holographic data which were memorized by this invention are explained to a detail. The graphic memory system 700 has the optical processor 735. The plane wave signal 105 passes this processor, and a ing object beam generates it from this processor. The object beam 740 includes the holographic data with which the ıest was memorized. The object beam 740 is turned to the holographic memory cell (HMC) 780 which can norize two or more holographic data, and contains desired holographic data and which can have memorized graphic data. The source 764 of a plane wave generates the plane wave signal 765 by which the collimation was ied out in general, and turns the plane wave signal 765 to HOE750. HOE750 contains the hologram of the graphic memory system (HMS) reference beam 760. Before reaching HOE750, plane wave signal 765' which the ıe wave signal 765 was operated with the filter 790, consequently was operated illuminates HOE750. In the example pening, a filter 790 consists of the immobilization or adjustable area openings which have a predetermined figuration. an opening configuration -- for example, a perfect circle form, an ellipse form, a rectangle (namely, slit), a hemicycle -- or they can be the size of arbitration, or the thing of a configuration as a matter of fact. However, the of arbitration or the thing of a configuration must differ from the plane wave signal 260,360 (for example, refer to ving 2 and drawing 3) used for the opening changing the plane wave signal 765, consequently operated plane wave ıal 765' generating HOE750 (that is, diameters differ). A filter 790 removes a high frequency component from the ıe wave signal 765, and restricts the bandwidth of a signal 765 effectively.
35] The data currently recorded from the first in HOE750 are recorded as a Fourier transform object. Therefore, vance exists between the frequency spectrum of the reference beam (namely, HOE reference beam) used in order to erate HOE, and frequency information being spatially recorded in HOE750. Therefore, when HOE750 is illuminated he plane wave signal which has a different space profile from a HOE reference beam, the storage spectrum ıponent from which a reference beam differs is illuminated, and modification reference beam 760' is generated by E750. Modification reference beam 760' actually has the contents of information which have different frequency ctrum from the reference beam used in order to record a hologram on HOE750 first, consequently were reduced by oval of some high frequency component. For example, modification reference beam 760' has the much more same k maximum (for example, refer to drawing 7 A) as wide band width-of-face selectivity (for example, refer to ving 7 B) and the original reference beam.
36] By expanding the width of face of the selectivity of a holographic memory system, this invention shoots quickly ıtion of the data of the arbitration of two or more holographic data memorized in the holographic memory cell, and ches them. The spatial frequency spectrum of a reference beam is controlled by carrying out orientation of the beam ugh the filter 790 which covers a part of reference beam, in order to remove a high frequency component from a rence beam. A filter 790 operates the plane wave signal 765, and, thereby, the full width at half maximum of lified plane wave signal 765' increases sharply (for example, refer to drawing 7 A and drawing 7 B). Therefore, the dwidth of a reference beam is expanded, maintaining a peak location as it is. Scanning resolution (space sensibility step resolution of a scan) required in order to trace the location of **** and specific holographic data falls sharply.

ısequently, still more quickly, the location is traced, and holographic data are searched, and the engine performance holographic memory system is improved sharply.

}7] The configuration (namely, size and a form) of opening of a filter controls the spatial frequency spectrum of the :n by which orientation is carried out through this opening. Generally, the high frequency component of a beam is :eased and/or is cut off as the area of opening decreases. This invention also plans a filter which increases the neter of the light beam which passes a filter again. Although some opening configurations have been explained, this :ntion is not limited to the specific configuration where it explained above, by not passing over these having strated to the last for explanation, and it is [0038]. Moreover, generally, as shown in drawing 7 A, for PCM)graphy, record of the hologram by the compound reference beam is important, and produces a generally very 'ow selectivity function. Therefore, the abnormality recording density (for example, about 300 channels bit icrometer] 2 **) of the holographic data in a holographic memory cell is possible by phase correlation multiplexing M) holography. For example, the full width at half maximum of correlation between a reference beam and storage)graphic data is less than about 5 micrometers. The peak value in drawing 7 A shows the diffraction reinforcement storage hologram as a function of a HMC location.

}9] Conventionally, the narrow corresponding selectivity function has also been needed for retrieval of storage)graphic data. About [that it takes time amount] and the costs of scanning to specification the holographic memory on which high density was made to accumulate two or more holographic data about holographic data was also high. ·ording to this invention, the selectivity function of a holographic memory system is made to extend or expand to a venient thing, and the quick location and quick read-out of holographic data from a holographic memory cell are le possible. The graph shown in drawing 7 B shows the selectivity function of the holographic memory system stituted by this invention. In this case, the reference beam is operated with the filter, as explained to the detail above. ıe location of desired storage holographic data is traced within a holographic memory cell, stored data can be 'oduced from one of the reference beams removing a filter, i.e., by opening opening.

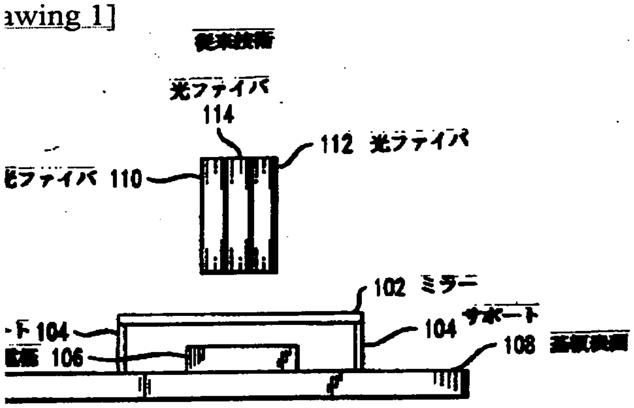
10]

ect of the Invention] According to this invention, as explained above, the width of face of the selectivity function of memorized hologram is increased, and the holographic data memorized by that cause can be searched still more :kly, and can be searched.

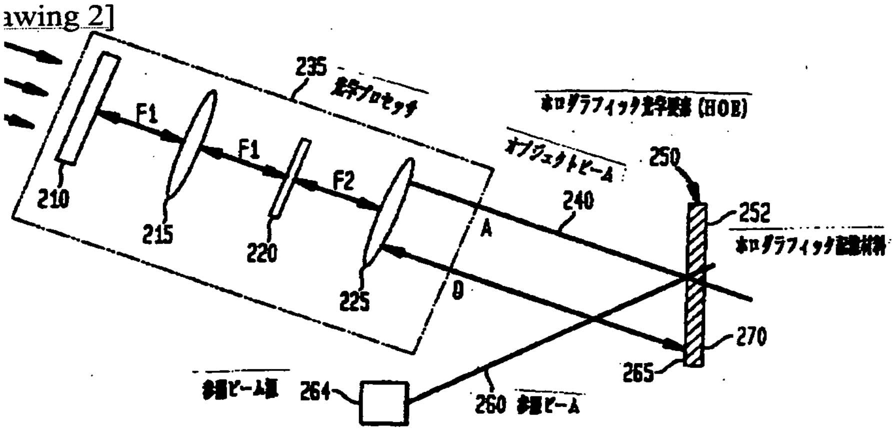
ınslation done.]

AWINGS

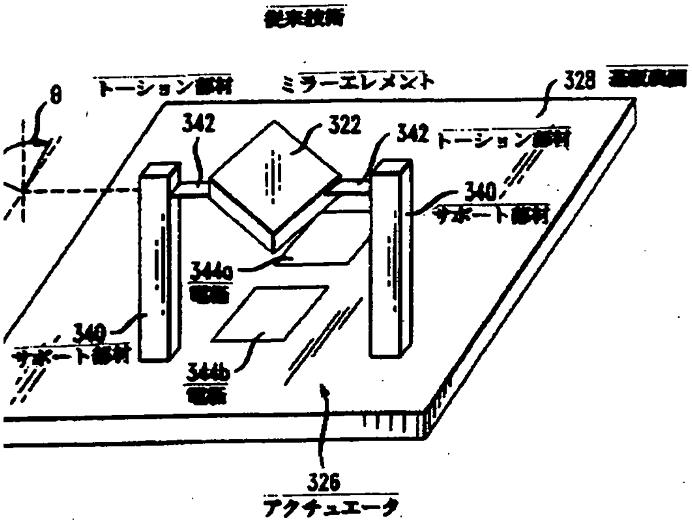
awing 1]



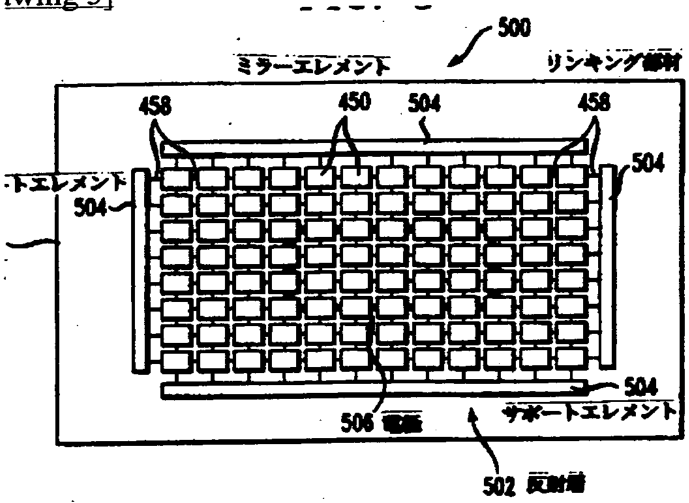
awing 2]



awing 3]



ıwing 5]



ıwing 4]

FIG. 4A

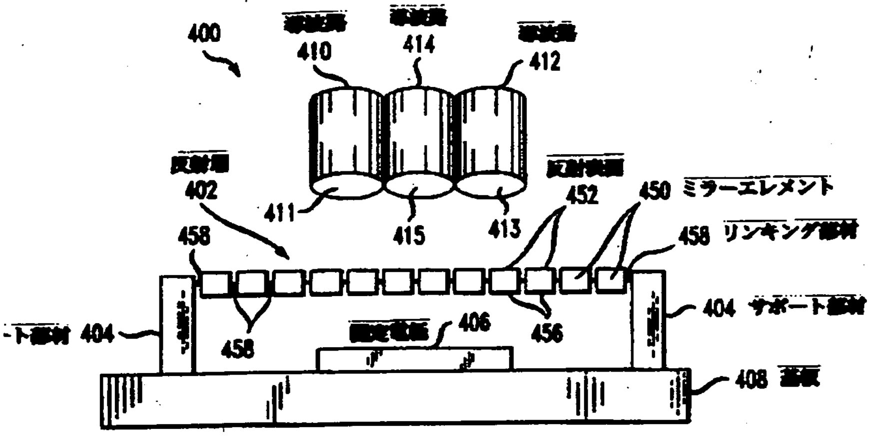
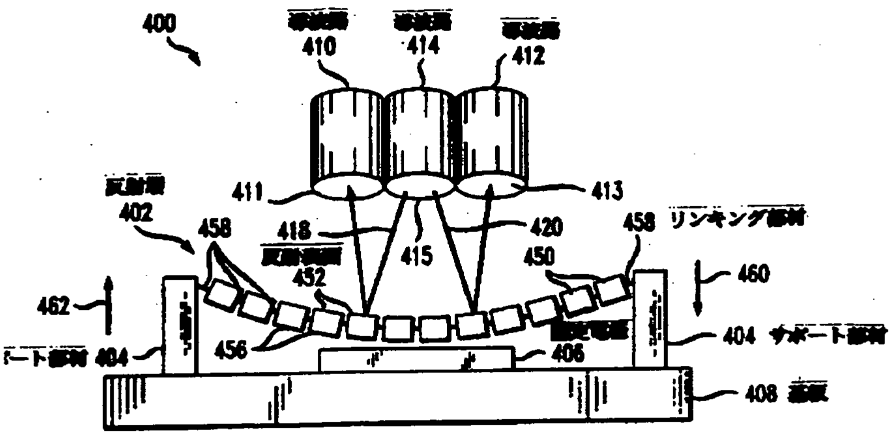
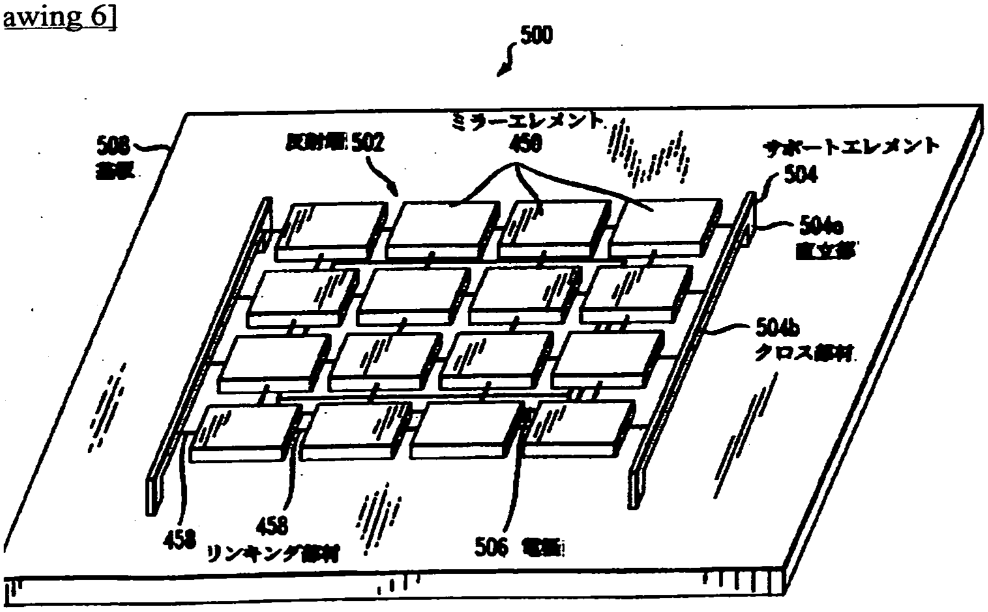


FIG. 4B

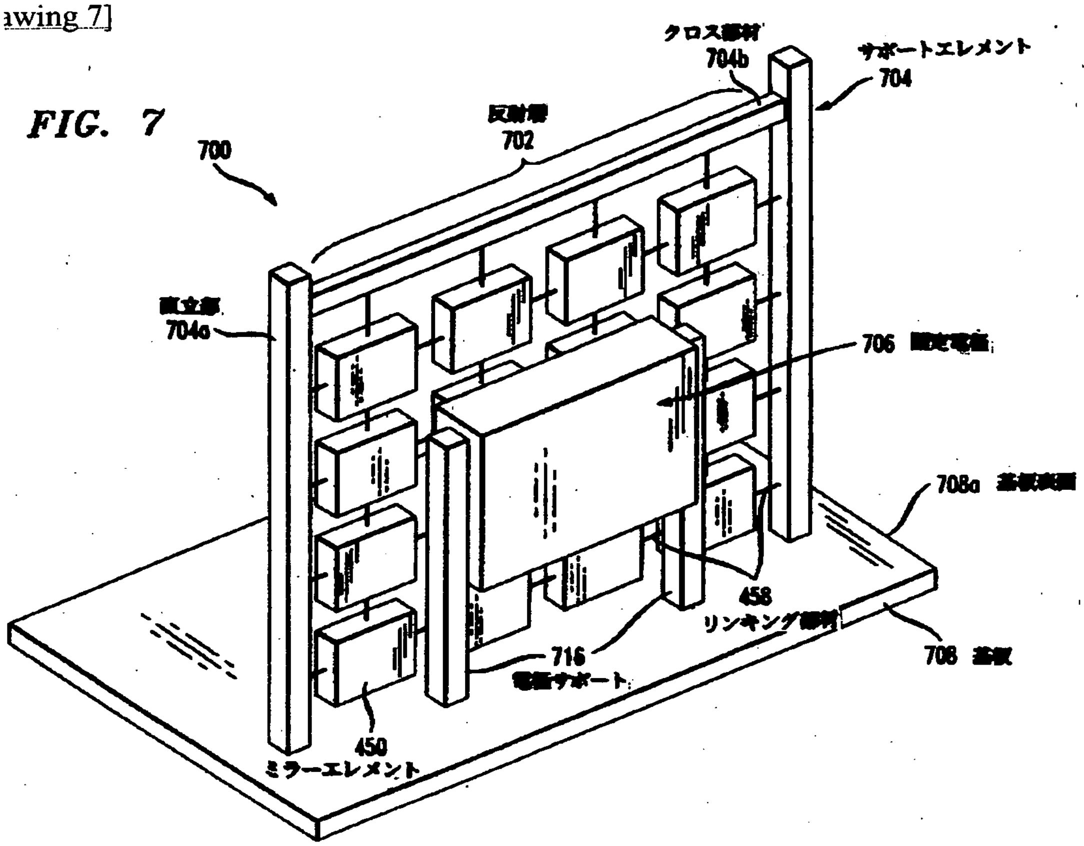


awing 6]



ɪwing 7]

FIG. 7



ɪnslation done.]

ϽTICES *

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ıis document has been translated by computer. So the translation may not reflect the original precisely.
:** shows the word which can not be translated.
the drawings, any words are not translated.

ꝜRRECTION OR AMENDMENT

ıd of official gazette] Printing of amendment by the convention of 2 of Article 17 of Patent Law
ɔtion partition] The 4th partition of the 6th section
ɔlication date] November 15, Heisei 14 (2002. 11.15)

ɔlication No.] JP,2001-60394,A (P2001-60394A)
te of Publication] March 6, Heisei 13 (2001. 3.6)
nual volume number] Open patent official report 13-604
plication number] Application for patent 2000-130591 (P2000-130591)
e 7th edition of International Patent Classification]

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C  13/04
B   5/32
H   1/04
2
G11B   7/0065
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C  13/04         C
B   5/32
H   1/04
2
B   7/0065
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ɔcedure revision]
ing Date] August 13, Heisei 14 (2002. 8.13)
ɔcedure amendment 1]
ıcument to be Amended] Specification
m(s) to be Amended] Claim
ɔthod of Amendment] Modification
ɔposed Amendment]
ıim(s)]
ıim 1] (a) The holographic memory cell which memorizes holographic data and it has inside (HMC),
The holographic optical element which memorizes the hologram of the holographic memory system (HMS)
ɔrence beam which has predetermined frequency spectrum, and it has inside (HOE),
The source of an object beam which generates an object beam and turns said object beam to said holographic
nory cell,
The source of a plane wave which generates a plane wave signal and turns said plane wave signal to said HOE,
It is arranged between said source of a plane wave, and said HOE, and has the filter which operates said plane wave
ıal,
; the phase correlation multiplexing (PCM) holographic memory system characterized by what said HOE turns a
dification HMS reference beam to said holographic memory cell when said HOE is irradiated by said operated plane
ve signal, and is projected.
aim 2] Said filter is a system according to claim 1 characterized by what said a part of plane wave signal is covered

im 3] Said filter is a system according to claim 2 characterized by what the high-frequency component of said plane
e signal is removed for.
im 4] Said filter is a system according to claim 2 characterized by what it consists of opening of fixed area and is
e for the orientation of said plane wave signal through this opening.
im 5] Said filter is a system according to claim 2 characterized by what it consists of opening of adjustable area and
one for the orientation of said plane wave signal through this opening.
im 6] Said source of an object beam,
Laser,
Optical processor
***,
system according to claim 1 characterized by what orientation of said laser is carried out through this optical
essor, and said object beam appears from this optical processor.
im 7] Said HOE is a system according to claim 1 characterized by what is been the transparent mode HOE.
im 8] Said HOE is a system according to claim 1 characterized by what is been in reflective mode HOE.
im 9] It is the approach of controlling the selectivity of the holographic memory system (HMS) which has the
ce of a plane wave which generates the source of an object beam which generates an object beam with the
graphic memory cell (HMC) which memorizes holographic data and it has inside, and the holographic optical
nent (HOE) which memorizes the hologram of a HMS reference beam and it has inside, and turns said object beam
id holographic memory cell, and a plane wave signal, and turns said plane wave signal to said HOE, and is this
oach,
selectivity control approach of the holographic memory system (HMS) characterized by having the step which
ates said plane wave signal in order that said HOE may turn and project a modification HMS reference beam on
holographic memory cell, when said HOE is illuminated by the operated plane wave signal.
im 10] It is the approach of tracing the holographic data storage location used with the holographic memory system
essing the holographic optical element (HOE) which is memorized by the holographic storage ingredient which has
or more holographic data memorized inside, and memorizes the hologram of a holographic memory system (HMS)
le, and it has, and is this approach,
The step which turns an object beam to said holographic storage ingredient,
The holographic data storage location **** approach characterized by having the step which operates said plane
e signal turned to said HOE in order that said HOE may turn and project a modification HMS reference beam on
holographic storage ingredient, when said HOE is illuminated by the operated plane wave signal.
im 11] It is the system with which the holographic data storage location memorized in the holographic storage
edient is traced and searched, and is this system,
The holographic optical element which memorizes the hologram of a HMS reference beam and it has inside (HOE),
The light source which generates the lightwave signal by which the collimation was carried out in general, and turns
lightwave signal to said HOE,
t is arranged between said light source and said HOE, and has the filter which operates said lightwave signal,
y are holographic data storage location **** and the retrieval system characterized by what said HOE turns a
lification reference beam to said holographic storage ingredient when said HOE is irradiated by said operated
twave signal, and is projected.

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nslation done.]

(19)日本国特許庁（ＪＰ）

(12) **公開特許公報**(Ａ)

(11)特許出願公開番号
特開2001－60394
(P2001－60394A)

(43)公開日　平成13年3月6日(2001.3.6)

(51)Int.Cl.⁷	識別記号	ＦＩ	テーマコード゛(参考)
Ｇ１１Ｃ　13/04		Ｇ１１Ｃ　13/04	Ｃ
Ｇ０２Ｂ　5/32		Ｇ０２Ｂ　5/32	
Ｇ０３Ｈ　1/04		Ｇ０３Ｈ　1/04	
1/22		1/22	
// Ｇ１１Ｂ　7/0065		Ｇ１１Ｂ　7/0065	

審査請求　未請求　請求項の数23　ＯＬ　外国語出願　（全 35 頁）

(21)出願番号　特願2000－130591(P2000－130591)

(22)出願日　平成12年4月28日(2000.4.28)

(31)優先権主張番号　０９／３０４０３１

(32)優先日　平成11年5月3日(1999.5.3)

(33)優先権主張国　米国（ＵＳ）

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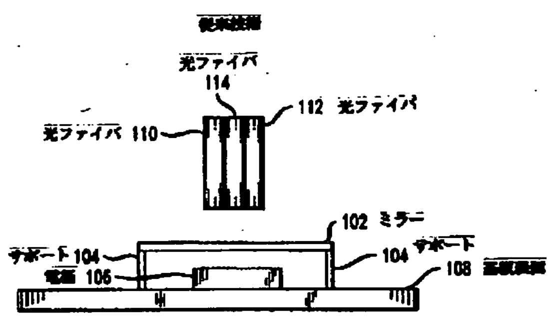
最終頁に続く

(54)【発明の名称】　位相相関多重化（ＰＣＭ）ホログラフィックメモリシステム

(57)【要約】
【課題】　記憶されたホログラムの選択性関数の幅を増大させ、それにより記憶されたホログラフィックデータを一層迅速にサーチし、検索することができる装置及び方法を提供する。
【解決手段】　ホログラフ的に記憶されたデータの一層迅速なロケーション（記憶位置の突き止め）と検索を可能にする、ホログラフィックメモリシステムにおける選択性関数の制御システム及び方法により解決される。本発明によれば、参照ビームを例えば、開口のようなフィルタにより、ビームが、参照ビームのホログラムが記憶されたホログラフィック光学要素を照射する前に、ビームを制限帯域幅に割り当てる。



【特許請求の範囲】
【請求項１】　(a)ホログラフィックデータを記憶して内部に有するホログラフィックメモリセル（HMC）と、
(b)所定の周波数スペクトルを有するホログラフィックメモリシステム（HMS）参照ビームのホログラムを記憶して内部に有するホログラフィック光学要素（ＨＯＥ）と、
(c)オブジェクトビームを発生し、かつ、前記オブジェクトビームを前記ホログラフィックメモリセルに向けるオブジェクトビーム源と、
(d)平面波信号を発生し、かつ、前記平面波信号を前記ＨＯＥに向ける平面波源と、
(e)前記平面波源と前記ＨＯＥとの間に配置され、前記平面波信号を操作するフィルタとからなり、
前記被操作平面波信号により前記ＨＯＥが照射されたときに、前記ＨＯＥは変更HMS参照ビームを前記ホログラフィックメモリセルに向けて投射する、ことを特徴とする位相相関多重化（ＰＣＭ）ホログラフィックメモリシステム。
【請求項２】　前記フィルタは前記平面波信号の一部分を覆い隠す、ことを特徴とする請求項１に記載のシステム。
【請求項３】　前記フィルタは前記平面波信号の高周波数成分を除去する、ことを特徴とする請求項２に記載のシステム。
【請求項４】　前記フィルタは一定面積の開口部からなり、該開口部を通して前記平面波信号が配向される、ことを特徴とする請求項２に記載のシステム。
【請求項５】　前記フィルタは可変面積の開口部からなり、該開口部を通して前記平面波信号が配向される、ことを特徴とする請求項２に記載のシステム。
【請求項６】　前記オブジェクトビーム源は、
(ｲ)レーザと、
(ﾛ)光学プロセッサとからなり、
該光学プロセッサを通して前記レーザが配向され、かつ、該光学プロセッサから前記オブジェクトビームが出現する、ことを特徴とする請求項１に記載のシステム。
【請求項７】　前記ＨＯＥは透過モードＨＯＥである、ことを特徴とする請求項１に記載のシステム。
【請求項８】　前記ＨＯＥは反射モードＨＯＥである、ことを特徴とする請求項１に記載のシステム。
【請求項９】　ホログラフィックデータを記憶して内部に有するホログラフィックメモリセル（HMC）と、ＨＭＳ参照ビームのホログラムを記憶して内部に有するホログラフィック光学要素（ＨＯＥ）と、オブジェクトビームを発生し、かつ、前記オブジェクトビームを前記ホログラフィックメモリセルに向けるオブジェクトビーム源と、平面波信号を発生し、かつ、前記平面波信号を前記ＨＯＥに向ける平面波源とを有するホログラフィックメモリシステム（HMS）の選択性を制御する方法であり、該方法は、
操作された平面波信号により前記ＨＯＥが照明されたときに、前記ＨＯＥが変更HMS参照ビームを前記ホログラフィックメモリセルに向けて投射するために、前記平面波信号を操作するステップからなる、ことを特徴とするホログラフィックメモリシステム（HMS）の選択性制御方法。
【請求項１０】　前記平面波信号の一部分を覆い隠すステップを更に有する、ことを特徴とする請求項９に記載の方法。
【請求項１１】　前記平面波信号の高周波数成分を除去するステップを更に有する、ことを特徴とする請求項９に記載の方法。
【請求項１２】　一定面積の開口部を通して前記平面波信号を配向するステップを更に有する、ことを特徴とする請求項９に記載の方法。
【請求項１３】　可変面積の開口部を通して前記平面波信号を配向するステップを更に有する、ことを特徴とする請求項９に記載の方法。
【請求項１４】　内部に記憶された複数のホログラフィックデータを有するホログラフィック記憶材料に記憶され、かつ、ホログラフィックメモリシステム（HMS）のホログラムを内部に記憶して有するホログラフィック光学要素（ＨＯＥ）を具備するホログラフィックメモリシステムで使用されるホログラフィックデータの記憶位置を突き止める方法であり、該方法は、
(a)オブジェクトビームを前記ホログラフィック記憶材料に向けるステップと、
(b)操作された平面波信号により前記ＨＯＥが照明されたときに、前記ＨＯＥが変更HMS参照ビームを前記ホログラフィック記憶材料に向けて投射するために、前記ＨＯＥに向けられる前記平面波信号を操作するステップとからなる、ことを特徴とするホログラフィックデータの記憶位置突止方法。
【請求項１５】　前記ステップ(b)は、前記平面波信号の一部分を覆い隠すことからなる、ことを特徴とする請求項１４に記載の方法。
【請求項１６】　前記ステップ(b)は、前記平面波信号の高周波数成分を除去することからなる、ことを特徴とする請求項１４に記載の方法。
【請求項１７】　前記ステップ(b)は、一定面積の開口部を通して前記平面波信号を配向することからなる、ことを特徴とする請求項１４に記載の方法。
【請求項１８】　前記ステップ(b)は、可変面積の開口部を通して前記平面波信号を配向することからなる、ことを特徴とする請求項１４に記載の方法。
【請求項１９】　ホログラフィック記憶材料内に記憶されたホログラフィックデータの記憶位置を突止め、検索するシステムであり、該システムは、

(a)ＨＭＳ参照ビームのホログラムを記憶して内部に有するホログラフィック光学要素（ＨＯＥ）と、
(b)概ね視準された光信号を発生し、かつ、前記光信号を前記ＨＯＥに向ける光源と、
(c)前記光源と前記ＨＯＥとの間に配置され、前記光信号を操作するフィルタとからなり、
前記被操作光信号により前記ＨＯＥが照射されたときに、前記ＨＯＥは変更参照ビームを前記ホログラフィック記憶材料に向けて投射する、ことを特徴とするホログラフィックデータの記憶位置突止・検索システム。

【請求項２０】　前記フィルタは前記光信号の一部分を覆い隠す、ことを特徴とする請求項１９に記載のシステム。

【請求項２１】　前記フィルタは前記光信号の高周波数成分を除去する、ことを特徴とする請求項２０に記載のシステム。

【請求項２２】　前記フィルタは一定面積の開口部からなり、該開口部を通して前記光信号が配向される、ことを特徴とする請求項２０に記載のシステム。

【請求項２３】　前記フィルタは可変面積の開口部からなり、該開口部を通して前記光信号が配向される、ことを特徴とする請求項２０に記載のシステム。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明はホログラフィックメモリシステムに関する。更に詳細には、本発明は、ホログラフィックメモリシステムの選択性を制御するシステム及び方法に関する。

【０００２】

【従来の技術】ホログラフィックメモリ又は記憶システムは、ニオブ酸リチウムの結晶のような記憶媒体の容量内に刻印される屈折率及び／又は吸収の変化パターンとして、データ要素（すなわち、ホログラム）のホログラフィック表示の三次元記憶を必要とする。ホログラフィックメモリシステム（ＨＭＳ）は、高密度記憶潜在能力及び記憶データにランダムにアクセスし変換する潜在的速度を特徴とする。

【０００３】一般的に、データ符号化オブジェクトビームを位相コヒーレント参照ビームと結合させ、ホログラフィックメモリセル（ＨＭＣ）のような感光性記憶媒体の隅から隅まで干渉パターンを生成することにより動作する。干渉パターンはホログラムを記録するＨＭＣ内の材料変性を誘発する。記憶媒体内のホログラムの応答は、オブジェクトビーム及び参照ビームの相対的振幅及びオブジェクトビームと参照ビームの位相差の関数である。また、この応答は、入射ビームの波長及び、オブジェクトビーム及び参照ビームが記憶媒体へ投射されるときの角度に大幅に依存する。

【０００４】ホログラフィー的に記憶されたデータは、データをＨＭＣに記憶するのに使用された参照ビームと

類似の参照ビームを、ホログラムを生成するのに使用される同じ角度、波長、位相及び位置で投射することにより再生される。ホログラム及び参照ビームは相互作用し、記憶されたオブジェクトビーム（すなわち、データ）を再生する。その後、再生されたオブジェクトビームは例えば、受光素子アレーを用いて検出される。次いで、回復データは出力デバイスへ送信するために事後処理される。

【０００５】一般的に、ホログラフィック記憶媒体の動的範囲は、容認可能な信号対雑音（Ｓ／Ｎ）比を有する単一のホログラムを記憶するのに必要な動的範囲よりも大きい。従って、一層大きな記憶密度を達成するために、記憶媒体内の或る位置における多数のホログラムを多重化することが望ましい。多重化技術の一つは、位相相関多重化（ＰＣＭ）である。この技術では、記憶媒体内の重複ホログラムを識別するために、相関選択性及びブラッグ(Bragg)選択性が使用される。相関選択性は、その参照ビームに関する記憶媒体の相対シフト（任意方向）により生成される参照ビームの、振幅、位相及び角度内容に依拠する。

【０００６】しかし、ＰＣＭのような多重化方式は比較的複雑な参照ビームを必要とする。この参照ビームの生成には、複雑な位相マスク、高品質レンズ及びフーリエ平面空間フィルタリングが必要である。生憎、位相マスクの構造はデリケートであり、レンズは高価であるばかりか、嵩高である。また、フーリエ位相空間フィルタは、入射光エネルギーの大部分をブロックし、システムの出力供給を大幅に増大させる。また、ＰＣＭホログラフィックメモリシステムの場合、これら構成要素の位置合わせはミクロン（μm）以下のレベル精度で行う必要があり、更に、一般的に、システム毎に整合させなければならない。このような整合性のレベルは、常用の部品類及び技術を用いて行うことが不可能でないとしても、非常に困難である。ホログラフィックメモリシステム用の参照ビームを生成又は再生するために、ホログラフィック光学要素（ＨＯＥ）を使用することができる。従って、ＨＯＥは、ＨＭＳにおける参照ビームを生成するために一般的に必要な１個以上の光学要素の比較的安価で、簡単な再現可能な整合配置をもたらす。ＨＯＥの一例は、米国特許出願第０８／９６８，０２４号明細書に開示されている。

【０００７】ホログラフィックメモリシステムにおけるＰＣＭ又はその他の相関選択性技術を使用する場合、ＨＭＣに記憶された生成情報は、比較的高い解像度、従って、高選択性を特徴とする。高解像度及び高選択性は望ましい特性であり、しかも、ＨＭＣによるホログラムの高密度記録には正に必要であるが、記憶されたホログラフィックデータの検索にも高解像度及び高選択性技術と装置が必要である。

【０００８】

【発明が解決しようとする課題】従って、本発明の目的は、記憶されたホログラムの選択性関数の幅を増大させ、それにより記憶されたホログラフィックデータを一層迅速にサーチし、検索する能力を提供することである。

【０００９】

【課題を解決するための手段】前記課題は、ホログラフ的に記憶されたデータの一層迅速なロケーション（記憶位置の突き止め）と検索を可能にする、ホログラフィックメモリシステムにおける選択性関数の制御システム及び方法により解決される。本発明によれば、参照ビームを例えば、開口のようなフィルタにより、ビームが、参照ビームのホログラムが記憶されたホログラフィック光学要素を照射する前に、ビームを制限帯域幅に割り当てる。

【００１０】本発明は、位相相関多重化（ＰＣＭ）ホログラフィックメモリシステム（ＨＭＳ）を提供する。このＰＣＭは、この中に記憶されたホログラフィックデータを有するホログラフィックメモリセル（ＨＭＣ）を包含する。また、ＰＣＭホログラフィックメモリシステムは、所定の周波数スペクトルを有するＨＭＳ参照ビームのホログラムが記憶されたホログラフィック光学要素（ＨＯＥ）も有する。オブジェクトビームを生成し、このオブジェクトビームをホログラフィックメモリセルに向けるためのオブジェクトビーム源が配設されている。平面波信号を生成し、この平面波信号をＨＯＥに向けるための平面波源も配設されている。また、本発明のＰＣＭホログラフィックメモリシステムは、平面波光学野を操作するためのフィルタ（平面波源とＨＯＥとの間に配置されている）も有する。操作された平面波信号によりＨＯＥが照射されると、ＨＯＥは変更ＨＭＳ参照ビームをホログラフィックメモリセルに向かって投射する。

【００１１】本発明は、ホログラフィックデータが記憶されたホログラフィックメモリセル（ＨＭＣ）を有するホログラフィックメモリシステム（ＨＭＳ）の選択性を制御する方法も提供する。このＨＭＳは、ＨＭＳ参照ビームのホログラムが記憶されたホログラフィック光学要素（ＨＯＥ）と、オブジェクトビームを生成し、このオブジェクトビームをホログラフィックメモリセルに向けるためのオブジェクトビーム源と、平面波信号を生成し、この平面波信号をＨＯＥに向けるための平面波源も包含する。この制御方法は平面波信号を操作するステップからなり、操作された平面波信号によりＨＯＥが照射されたときに、ＨＯＥは変更ＨＭＳ参照ビームをホログラフィックメモリセルに向けて投射する。

【００１２】更に、本発明は、ＨＭＳ参照ビームのホログラムが記憶されたホログラフィック光学要素（ＨＯＥ）を有するホログラフィックメモリシステム（ＨＭＳ）で使用される複数のホログラフィックデータを有するホログラフィック記憶材料内に記憶されたホログラフィックデータの記憶位置を突き止める方法も提供する。この実施態様の方法は、オブジェクトビームをホログラフィック記憶材料に向けることからなる。この方法は更に、ＨＯＥに向けられる平面波信号を操作するステップも有する。これにより、操作された平面波信号によりＨＯＥが照射されたときに、ＨＯＥは変更ＨＭＳ参照ビームをホログラフィック記憶材料に向けて投射する。

【００１３】更に、本発明は、ホログラフィック記憶材料中に記憶されたホログラフィックデータの記憶位置を突き止め、検索するシステムも提供する。この実施態様のシステムは、参照ビームのホログラムが記憶されたホログラフィック光学要素（ＨＯＥ）を有する。このシステムは更に、概ね視準された光信号を生成し、この光信号をＨＯＥに向けるための光源も有する。また、このシステムは、光信号を操作するための、光源とＨＯＥとの間に配置されたフィルタも有する。操作された光信号でＨＯＥが照射されると、ＨＯＥは変更参照ビームをホログラフィック記憶材料に向けて投射する。

【００１４】

【発明の実施の形態】ホログラフィック記憶材料内の高記録密度を得るために多数のホログラムを多重化する技術の一例は、位相相関多重化（ＰＣＭ）である。位相相関多重化は米国特許第５７１９６９１号公報に開示されている。

【００１５】この明細書で使用される、「ホログラフィック媒体」又は「ホログラフィック記憶材料」という用語は、内部にホログラムを記録することができる光化学作用を有する材料を意味する。この材料は、例えば、分散銀ハロゲン化物粒子を含有するフィルム、アクリレート系ホトポリマー又は自立性ＬｉNbO_3結晶などのような様々な形態をとることができる。

【００１６】この明細書で使用される、「ホログラフィック光学要素（ＨＯＥ）」という用語は、ホログラフィックメモリシステム（ＨＭＳ）内で使用される参照ビームの一つ又は複数のホログラムを示すことができる屈折光学体を意味する。ＨＯＥは、平面波信号（すなわち、ＨＯＥ参照ビーム）とオブジェクトビーム（すなわち、ＨＭＳ参照ビーム）との間のホログラフィック記憶材料内の干渉により、生成、発生、形成等々させることができる。ＨＯＥは、ホログラムを記録するのに好適な任意の材料から構成することができる。ＨＯＥが生成されると、ＨＭＳ参照ビームは、ＨＯＥ参照ビームと同一の特性を有する平面波（すなわち、概ね視準された光信号）をＨＯＥに向けることにより再生させることができる。従って、再生参照ビームは、光学プロセッサを必要とすること無くＨＭＳ参照ビームを生成する手段を提供する。従って、ＨＯＥは、光学プロセッサに取って代わる参照ビームを生成する単一の光学要素を提供し、参照ビームをホログラフィックメモリシステム内に生成させる方法を簡単にする。

【００１７】この明細書で使用される、「選択性」及び「選択性関数」という用語は、ホログラフィック記憶材料内に記憶された複数のホログラフィックデータ（又はホログラフィック情報）を識別するための、ホログラフィックメモリシステム（又はホログラフィックデータ（情報）を記録及び／又は検索するその他のシステム）の能力を意味する。ホログラフィックメモリシステムの選択性は、少なくとも一部分は、ホログラフィックデータ（情報）を記録及び検索するために使用される参照信号の帯域幅に応じて変化する。

【００１８】図1は、位相相関多重化（ＰＣＭ）ホログラフィックメモリシステム（ＨＭＳ）で使用される代表的な光学プロセッサ１３５を示す。光学プロセッサ１３５は、平面波信号１０５を符号化ビームに変換する。符号化ビームはＨＭＳ用の参照ビーム（すなわち、ＨＭＳ参照ビーム）として使用することができる。更に具体的には、平面波信号１０５（すなわち、レーザ光のコヒーレントビーム）は高精密参照マスク１１０（例えば、位相マスク及び／又は振幅マスク）を照射する。マスク１１０は、例えば、平面波信号の高空間帯域幅積を誘導することにより光ビーム１０５を符号化する。符号化ビームは、焦点距離ｆ１を有する第１のレンズ１１５まで距離ｆ１だけ伝搬する。第１のレンズ１１５を通過すると、第１のレンズ１１５を越えて別の距離ｆ１の地点に、参照位相マスク１１０のフーリエ変換体を生成する。ハイパス空間フィルタ１２０がフーリエ変換体の面位置に設けられている。フィルタ１２０は一般的に、参照マスク１１０から放射する低空間周波数の大部分をブロックする。ハイパスフィルタ１２０を通過した後、符号化ビームは、焦点距離ｆ２を有する第２のレンズ１２５まで距離ｆ２だけ伝搬する。符号化ビームは第２のレンズ１２５を通過し、別の距離ｆ２だけ伝搬し、その像面１３０に到達する。像面１３０において、符号化ビーム１４０（符号Ａが付されている）は、ホログラフィックメモリシステム（ＨＭＳ）の参照ビーム（すなわち、ＨＭＳ参照ビーム）として特徴付けることができる。

【００１９】像面１３０の位置にホログラフィック媒体を配置することにより、符号化ビーム１４０のホログラム（すなわち、ＨＭＳ参照ビームのホログラム）はホログラフィック媒体（図２及び図３参照）中に記憶させることができる。

【００２０】この明細書で使用される「参照ビーム」及び「オブジェクトビーム」という用語は、ＨＯＥを生成するために使用されるビーム及びホログラフィックメモリシステムで使用されるビームをそれぞれ意味する。従って、これら用語を区別して使用するため、適当に「ＨＯＥ」及び「ＨＭＳ」を付けて区別する。

【００２１】図２は、本発明によるホログラフィックメモリシステムで使用されるホログラフィック光学要素（ＨＯＥ）２５０の生成又は形成を示す。特に、図２は透過モードＨＯＥ２５０の生成を示す。（符号Ａが付された）ＨＯＥオブジェクトビーム２４０（ＨＭＳ参照ビームでもある）は、図１に関連して説明したように発生される。ＨＯＥオブジェクトビーム２４０は、ホログラフィック記憶材料２５２に向かって距離Ｄだけ、光学プロセッサ２３５から伝搬するか、又は別の方法で配向される。ＨＯＥオブジェクトビーム２４０はホログラフィック記憶材料２５２に入射し、そこで、ＨＯＥ参照ビーム２６０（平面波信号）と交差する。ＨＯＥ参照ビーム２６０はＨＯＥオブジェクトビーム２４０とコヒーレントである。ＨＯＥ参照ビーム２６０は、光源２６４により発生され、この光源からホログラフィック記憶材料２５２に向けられ、ホログラフィック記憶材料２５２を照明しそしてホログラフィック記憶材料２５２内の所定の位置でＨＯＥオブジェクトビーム２４０と交差する。ＨＯＥオブジェクトビーム２４０とＨＯＥ参照ビーム２６０との間で生成された干渉パターンは、ホログラフィック記憶材料２５２内でホログラムとして記録される。従って、ホログラフィック記憶材料２５２は、内部に記憶されたＨＯＥオブジェクトビーム２４０（すなわち、ＨＭＳ参照ビーム）のホログラムを有するホログラフィック光学要素（ＨＯＥ）２５０に変換される。

【００２２】ＨＯＥ参照ビーム２６０は好適な任意のビームであることができるが、一般的に、平面波又は容易に再生可能なその他のビームである。ＨＯＥオブジェクトビーム２４０及びＨＯＥ参照ビーム２６０は一般的に、当業者に公知の同一又は類似のレーザ光源からのコヒーレント光により生成される。

【００２３】ホログラフィック記憶材料２５２は好適な任意の材料であることもできるし、又は、表面ホログラム又は体積ホログラムの何れかを記録し、回折光学体を生成することができる材料の形状又はアレンジメントであることもできる。例えば、ホログラフィック記憶材料２５２は、ホトポリマー、ホトレジスト、熱可塑性材料、光屈折性材料又は光互換材料などである。ホログラフィック記憶材料２５２は一般的に、概ね平面状の第１の面２６５と、概ね平面状の、対向する第２の面２７０を有する。ホログラフィック記憶材料２５２は十分に平面状であるか、又は、１ｃｍ当たり概ね２波長の光に対して再生可能である。

【００２４】図３は、本発明によるホログラフィックメモリシステムで使用される反射モードホログラフィック光学要素（ＨＯＥ）３５０の生成又は形成を示す。図３に示されたＨＯＥ３５０は、図２に示され、前記に説明した透過モードＨＯＥ２５０と異なる形状を有する。更に特定的には、ＨＯＥ参照ビーム３６０は（ビームＢ）は光源３６４から発生され、ホログラフィック記憶材料３５２の第２の面に向けられ、ホログラフィック記憶材料３５２内の所定の位置でＨＯＥオブジェクトビーム（ビームＡ）と交差する。生成された干渉パターンは、

ホログラフィック記憶材料３５２内でＨＯＥオブジェクトビーム３４０のホログラムとして捕捉され、斯くして、ＨＯＥオブジェクトビーム３４０のＨＯＥ３５０が形成される。反射モードＨＯＥ３５０は次の点で透過モードＨＯＥ２５０と異なる。反射モードＨＯＥ３５０はホログラフィック記憶材料３５２の反対面に向けられたビームを用いて生成されるが、透過モードＨＯＥ２５０はホログラフィック記憶材料２５２の同じ面に向けられたビームを用いて生成される。

【００２５】透過モード及び反射モードホログラフィック光学要素（ＨＯＥ）の両方とも、多重化により該光学要素内に複数のＨＯＥオブジェクトビームを記憶することができる。例えば、ホログラフィック記憶材料が比較的厚い（例えば、１ｍｍ）場合、複数のＨＯＥオブジェクトビームはホログラフィック記憶材料内で多重化させ、複数のオブジェクトビームのＨＯＥを形成することとができる。複数のオブジェクトビームの多重化は、オブジェクトビーム特性を変化させながら、ＨＯＥ参照ビームの角度、波長又は位置を変化させることにより行うことができる。オブジェクトビーム特性の変化は、例えば、異なるマスク、フィルタ又はレンズ組合せ構成を使用することにより実施できる。

【００２６】図４Ａ及び図４Ｂは、本発明により構成されたホログラフィックメモリシステム（HMS）５００で使用される透過モードホログラフィック光学要素（ＨＯＥ）５５０を示す。ＨＯＥ５５０からのＨＯＥオブジェクトビーム５４０（ビームＡ）を再生するために、ＨＯＥ５５０を生成するために使用された参照ビーム同一又は類似の参照ビーム５６０が光源５６４から発生され、ＨＯＥ５５０に向けられ、ＨＯＥ５５０を照明する。照明の際にＨＯＥ５５０から放射するビームは、ＨＯＥオブジェクトビーム５４０（ビームＡ）の再生である。これは、ＨＯＥ５５０を生成するためにホログラフィック記憶材料５５２で元々捕捉されるオブジェクトビームであり、HMS参照ビームを示す。ＨＯＥ５５０に対する参照ビーム５６０の内容及び方向は、少なくとも部分的に、ホログラフィック光学要素５５０（例えば、図２に示され、前記で説明されたような光学要素）の生成中に第２のレンズの焦点距離ｆ２に比べて、光学プロセッサ５３５（図２参照）内の第２のレンズ５２５とホログラフィック記憶材料２５２との間の距離Ｄに応じて変化する。

【００２７】図４Ａに示されるように、ＨＯＥ５５０生成中の距離Ｄが第２のレンズの焦点距離ｆ２（図２参照）未満の場合、ＨＯＥオブジェクトビーム５４０の像面５７５（符号Ｐが付されている）はＨＯＥ５５０を越えて形成される。このような場合、ＨＯＥ５５０は、ＨＯＥ５５０を生成するために使用された場合と同様に、参照ビーム５６０を同じ面（すなわち、面５６５）に向けることにより照明される。その後、参照ビーム５６０とＨＯＥ５５０との相互作用によりＨＯＥオブジェクトビーム５４０が再生され、ＨＯＥ５５０を越えて、ＨＯＥオブジェクトビーム５４０の像面５７５（又は所望の他の面）を形成する。

【００２８】図４Ｂに示されるように、ＨＯＥ５５０生成中の距離Ｄが第２のレンズの焦点距離ｆ２（図２参照）よりも大きい場合、ＨＯＥオブジェクトビーム５４０の像面５７５（符号Ｐが付されている）はＨＯＥ５５０よりも手前又は正面に形成される。このような場合、光源５６３から発生された参照ビーム５６２の複合共役を使用し、第２の面、すなわち、ＨＯＥ５５０を生成するために使用されたものと同様な反対面から、ＨＯＥ５５０を照明する。ＨＯＥ参照ビーム５４２の複合共役（符号Ａ＊が付されている）は、参照ビーム５６２の複合共役とＨＯＥ５５０との相互作用により再生され、ＨＯＥ５５０の手前又は正面に、ＨＯＥオブジェクトビーム５４２の複合共役（符号Ａ＊が付されている）の所望の面５７５が形成される。

【００２９】図４Ａ及び図４Ｂに示された両方の実施態様において、ホログラフィックメモリシステム５００は、複数のホログラフィックデータを記憶することができるホログラフィックメモリセル（HMC）５８０を有する。HMC５８０は、この中に記憶される任意のホログラフィックデータのロケーション及び検索用の像面５７５に関連して配置される。ホログラフィックデータは、複数のホログラフィックデータの各々の間の高選択度により特徴付けられる比較的緊密な又は高密度に構成されたアレイとして、HMC５８０内に記憶される。例えば、ＰＣＭホログラフィックメモリシステムにおける記憶密度は約３００チャネルビット／μm^2である。

【００３０】図５Ａ及び図５Ｂは、本発明により構成されたホログラフィックメモリシステム６００の一部としての、反射モードホログラフィック光学要素（ＨＯＥ）６５０を示す。ＨＯＥオブジェクトビーム６４０（ビームＡ）は、光源６６４からの再生参照ビーム６６０をＨＯＥ６５０に向けて照射し、ＨＯＥ６５０を照明することにより再生される。ＨＯＥ６５０に対する再生参照ビーム６６０（ビームＢ）の内容及び方向は、少なくとも部分的に、ＨＯＥ６５０の生成中の第２のレンズの焦点距離ｆ２に比べて、光学プロセッサ６３５の第２のレンズ６２５（例えば、図３参照）とホログラフィック記憶材料６５２との間の距離Ｄに応じて変化する。

【００３１】図５Ａに示されるように、ＨＯＥ６５０の生成中の距離Ｄが第２のレンズの焦点距離ｆ２未満の場合、ＨＯＥオブジェクトビーム６４０の像面６７５（符号Ｐが付されている）はＨＯＥ６５０を越えて形成される。このような場合、ＨＯＥ６５０は、参照ビーム６６０を第２の面６７０に向けることにより照明される。その後、前記に説明したのと同様に、ＨＯＥオブジェクトビーム６４０は参照ビーム６６０とＨＯＥ６５０との相

互作用により再生され、ＨＯＥ６５０を越えた位置に、ＨＯＥオブジェクトビーム６４０の像面６７５（又は所望の他の面）を形成する。

【００３２】図５Ｂに示されるように、ＨＯＥ６５０の生成中の距離Ｄが第２のレンズの焦点距離ｆ２よりも大きい場合、ＨＯＥオブジェクトビーム６４２の複合共役（符号Ａ＊が付されている）の像面６７５（符号Ｐが付されている）はホログラフィック光学要素（ＨＯＥ）６５０の正面又は手前に形成される。このような場合、ＨＯＥ６５０は、光源６６３から発生された参照ビーム６６２の複合共役により照明される。参照ビーム６６２の複合共役は、ＨＯＥ６５０を生成するために使用されたものと反対側の第１の面６６５からＨＯＥ６５０を照明する。ＨＯＥオブジェクトビーム６４２の複合共役（符号Ａ＊が付されている）は、参照ビーム６６２の複合共役とＨＯＥ６５０との相互作用により再生され、ＨＯＥ６５０の手前又は正面に、ＨＯＥオブジェクトビーム６４２の複合共役（符号Ａ＊が付されている）の像面６７５又はその他の所望の面を形成する。

【００３３】図５Ａ及び図５Ｂに示された両方の実施態様において、ホログラフィックメモリシステム６００は、複数のホログラフィックデータを記憶することができるホログラフィックメモリセル（ＨＭＣ）６８０を有する。ＨＭＣ６８０は、この中に記憶される任意のホログラフィックデータのロケーョン及び検索用の像面６７５に関連して配置される。ホログラフィックデータは、複数の記憶されるホログラフィックデータの各々の間の高選択度により特徴付けられる比較的緊密な又は高密度に構成されたアレイとして、ＨＭＣ６８０内に記憶される。

【００３４】図４Ａ、図４Ｂ、図５Ａ及び図５Ｂは、一般的に、高密度形態でホログラフィック記憶媒体内にホログラフィックデータを記録又は格納するシステム及び方法を示すものである。次に図６を参照する。本発明により記憶されたホログラフィックデータのロケーションと検索について詳細に説明する。ホログラフィックメモリシステム７００は、光学プロセッサ７３５を有する。平面波信号１０５はこのプロセッサを通過し、そして、このプロセッサから符号化オブジェクトビームが発生する。オブジェクトビーム７４０は所望の記憶されたホログラフィックデータを包含する。オブジェクトビーム７４０は、複数のホログラフィックデータを記憶することができ、かつ、所望のホログラフィックデータを含む、記憶されたホログラフィックデータを有することができるホログラフィックメモリセル（ＨＭＣ）７８０に向けられる。平面波源７６４は概ね視準された平面波信号７６５を発生し、平面波信号７６５をＨＯＥ７５０に向ける。ＨＯＥ７５０は、ホログラフィックメモリシステム（ＨＭＳ）参照ビーム７６０のホログラムを含む。ＨＯＥ７５０に到達する前に、平面波信号７６５は、フィルタ７９０により操作され、その結果、操作された平面波信号７６５’はＨＯＥ７５０を照明する。開口の具体例において、フィルタ７９０は所定の形状を有する固定又は可変エリア開口から構成される。開口形状は例えば、真円形、楕円形、矩形（すなわち、スリット）、半円形又は事実上任意のサイズ又は形状のものであることができる。但し、任意のサイズ又は形状のものは、その開口が平面波信号７６５を変更し、その結果、被操作平面波信号７６５’が、ＨＯＥ７５０を生成するのに使用された平面波信号２６０，３６０（例えば、図２及び図３参照）と異なる（すなわち、直径が異なる）ものとならなければならない。フィルタ７９０は、平面波信号７６５から高周波成分を除去し、信号７６５の帯域幅を効果的に制限する。

【００３５】ＨＯＥ７５０内に元々記録されているデータはフーリエ変換体として記録される。従って、ＨＯＥを生成するために使用された参照ビーム（すなわち、ＨＯＥ参照ビーム）の周波数スペクトルと、周波数情報がＨＯＥ７５０内に空間的に記録されることとの間には関連性が存在する。従って、ＨＯＥ７５０がＨＯＥ参照ビームと異なる空間プロファイルを有する平面波信号により照明される場合、参照ビームの異なる記憶スペクトル成分が照明され、そして、変更参照ビーム７６０’がＨＯＥ７５０により生成される。変更参照ビーム７６０’は、ＨＯＥ７５０にホログラムを最初に記録するために使用された参照ビームと異なる周波数スペクトルを有し、その結果、若干の高周波成分の除去により、減容された情報内容を実際に有する。例えば、変更参照ビーム７６０’は、一層広い帯域幅選択性（例えば、図７Ｂ参照）と、元の参照ビームと同じピーク最大値（例えば、図７Ａ参照）を有する。

【００３６】本発明は、ホログラフィックメモリシステムの選択性の幅を広げることにより、ホログラフィックメモリセル内に記憶された複数のホログラフィックデータのうちの任意のデータを迅速にロケーションし、検索する。参照ビームの空間周波数スペクトルは、参照ビームから高周波数成分を除去するために参照ビームの一部分を覆い隠すフィルタ７９０を通してビームを配向することにより制御される。フィルタ７９０は、平面波信号７６５を操作し、それにより、変更平面波信号７６５’の半値全幅が大幅に増大される（例えば、図７Ａ及び図７Ｂ参照）。従って、参照ビームの帯域幅は、ピーク位置はそのまま維持しながら、拡大される。よて、特定のホログラフィックデータの位置を突き止めるために必要なスキャン解像度（空間感度及びスキャンのステップ解像度）は大幅に低下される。その結果、ホログラフィックデータは一層迅速にその位置が突き止められ、かつ、検索され、ホログラフィックメモリシステムの性能が大幅に改善される。

【００３７】フィルタの開口の形状（すなわち、サイズ

及び形）が、この開口を通して配向されるビームの空間周波数スペクトルを制御する。一般的に、開口の面積が減少するにつれて、ビームの高周波成分は減衰され、及び／又はカットオフされる。本発明はまた、フィルタを通過する光ビームの直径を増大させるようなフィルタも企図する。幾つかの開口形状について説明してきたが、これらはあくまでも説明のために例示したに過ぎず、本発明は前記に説明したような特定の形状に限定されるものではなく、

【００３８】また、一般的に、図７Ａに示されるように、複合参照ビームによるホログラムの記録はＰＣＭホログラフィーにとって重要であり、概して非常に狭い選択性関数を生じる。従って、ホログラフィックメモリセルにおけるホログラフィックデータの異常記録密度（例えば、約３００チャネルビット／μm^2超）は、位相相関多重化（ＰＣＭ）ホログラフィーにより可能である。例えば、参照ビームと記憶ホログラフィックデータとの間の相関の半値全幅は約５μｍ未満である。図７Ａにおけるピーク値はＨＭＣ位置の関数として、記憶ホログラムの回折強度を示す。

【００３９】記憶ホログラフィックデータの検索には従来は、対応する狭い選択性関数も必要としてきた。複数のホログラフィックデータを高密度に集積させたホログラフィックメモリセルを特定にホログラフィックデータについてスキャンすることは時間がかかるばかりか、費用も高かった。好都合なことに、本発明によれば、ホログラフィックメモリシステムの選択性関数を拡張又は拡大させ、ホログラフィックメモリセルからのホログラフィックデータの迅速なロケーション及び読み出しを可能にする。図７Ｂに示されたグラフは、本発明により構成されたホログラフィックメモリシステムの選択性関数を示す。この場合、参照ビームは前記で詳細に説明したようにフィルタにより操作されている。所望の記憶ホログラフィックデータの位置がホログラフィックメモリセル内で突き止められたら、参照ビームの一つからフィルタを除去することにより、すなわち、例えば、開口を開放することにより、記憶データを再生させることができる。

【００４０】

【発明の効果】以上説明したように、本発明によれば、記憶されたホログラムの選択性関数の幅を増大させ、それにより記憶されたホログラフィックデータを一層迅速にサーチし、検索することができる。

【図面の簡単な説明】

【図１】平面波信号を符号化オブジェクト信号に変換する光学プロセッサの模式的構成図である。

【図２】位相相関多重化ホログラフィックメモリシステム用の透過モードホログラフィック光学要素の形成を示す模式的構成図である。

【図３】位相相関多重化ホログラフィックメモリシステム用の反射モードホログラフィック光学要素の形成を示す模式的構成図である。

【図４】本発明により構成された位相相関多重化ホログラフィックメモリシステムにおける図２のホログラフィック光学要素の使用状態を示す模式的構成図であり、（Ａ）は、ＨＯＥ５５０生成中の距離Ｄが第２のレンズの焦点距離ｆ２未満の場合の使用状態を示し、（Ｂ）は、ＨＯＥ５５０生成中の距離Ｄが第２のレンズの焦点距離ｆ２よりも大きい場合の使用状態を示す。

【図５】本発明により構成された位相相関多重化ホログラフィックメモリシステムにおける図３のホログラフィック光学要素の使用状態を示す模式的構成図であり、（Ａ）は、ＨＯＥ６５０生成中の距離Ｄが第２のレンズの焦点距離ｆ２未満の場合の使用状態を示し、（Ｂ）は、ＨＯＥ６５０生成中の距離Ｄが第２のレンズの焦点距離ｆ２よりも大きい場合の使用状態を示す。

【図６】本発明により構成されたホログラフィックメモリシステムの模式的構成図である。

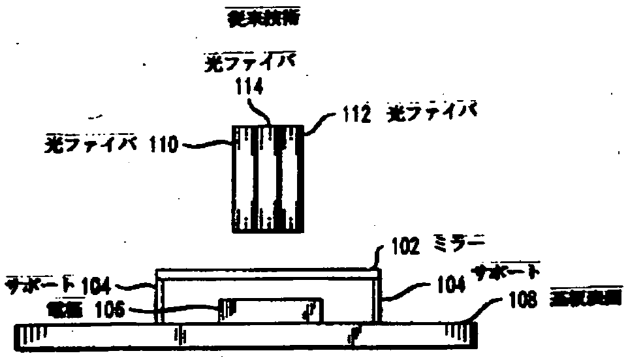
【図７】ホログラフィックメモリシステムの選択性関数の特性図であり、（Ａ）は従来技術のホログラフィックメモリシステムの選択性関数の特性図であり、（Ｂ）は本発明により構成されたホログラフィックメモリシステムの選択性関数の特性図である。

【符号の説明】

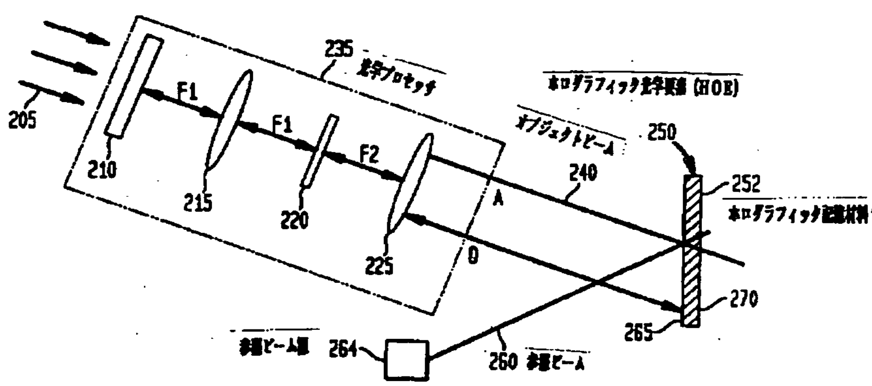
１０５　平面波信号
１１０　参照マスク
１１５　第１のレンズ
１２０　ハイパスフィルタ
１２５　第２のレンズ
１３０　像面
１３５　光学プロセッサ
１４０　符号化ビーム
２３５，３３５　光学プロセッサ
２４０，３４０　オブジェクトビーム
２５０，３５０　ホログラフィック光学要素（ＨＯＥ）
２５２，３５２　ホログラフィック記憶材料
２６０，３６０　参照ビーム
２６４，３６４　参照ビーム源
２６５，３６５　第１の面
３６５，３７０　第２の面
５４０，５４２　オブジェクトビーム
５５０　ホログラフィック光学要素（ＨＯＥ）
５５２　ホログラフィック記憶材料
５６０，５６２　参照ビーム
５６３，５６４　参照ビーム源
５６５　第１の面
５７０　第２の面
５７５　像面
５８０　ホログラフィックメモリセル
６００　ホログラフィックメモリシステム

６５０　ホログラフィック光学要素
６４０，６４２　オブジェクトビーム
６５０　ホログラフィック光学要素（ＨＯＥ）
６５２　ホログラフィック記憶材料
６６０，６６２　参照ビーム
６６３，６６４　参照ビーム源
６６５　第１の面
６７０　第２の面
６７５　像面
５８０　ホログラフィックメモリセル
７００　ホログラフィックメモリシステム
７３５　光学プロセッサ
７４０　オブジェクトビーム
７５０　ホログラフィック光学要素（ＨＯＥ）
７６０　変更参照ビーム
７６４　平面波源
７６５　平面波信号
７６５'　被操作平面波信号
７８０　ホログラフィックメモリセル（ＨＭＣ）
７９０　フィルタ

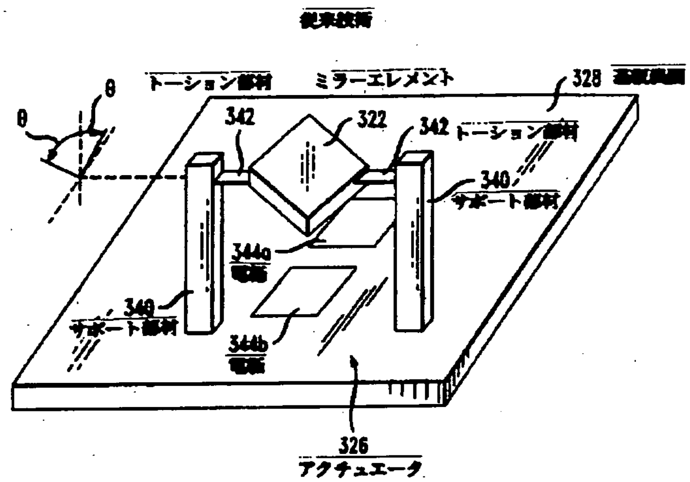
【図１】



【図２】



【図３】


従来技術
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ミラーエレメント
328
θ
θ
342
322
342
トーション部材
340
サポート部材
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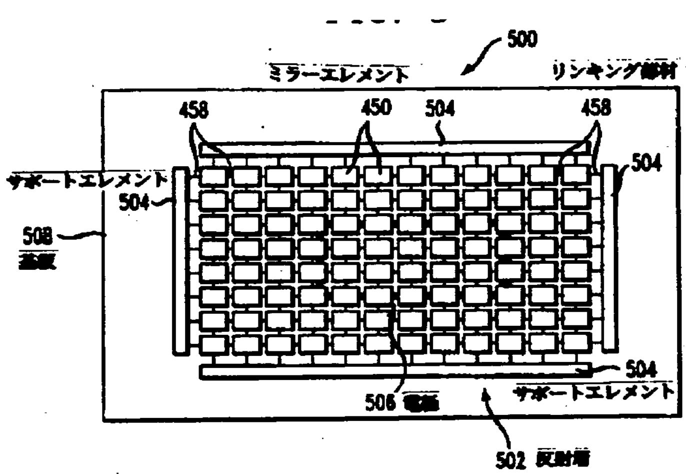
電極
340
サポート部材
344b
電極
326
アクチュエータ

【図５】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450
504
458
サポートエレメント
504
504
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基板
504
サポートエレメント
506 電極
502 反射層

【図４】

FIG. 4A

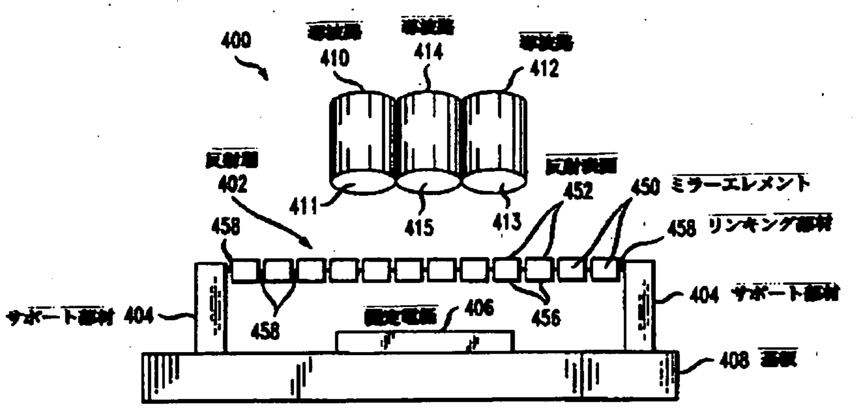
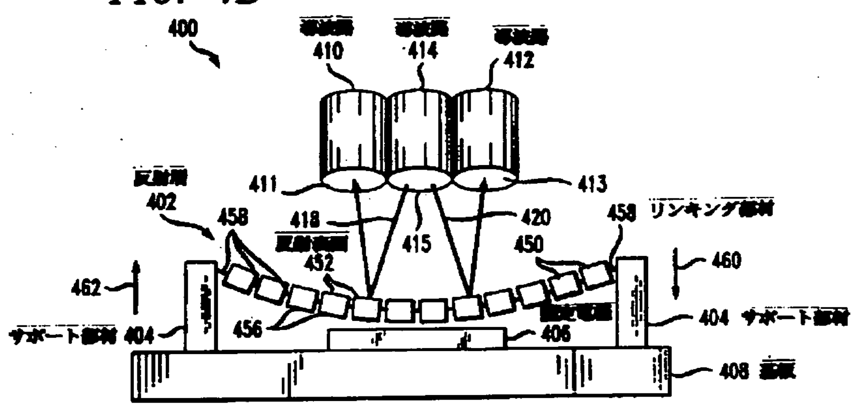
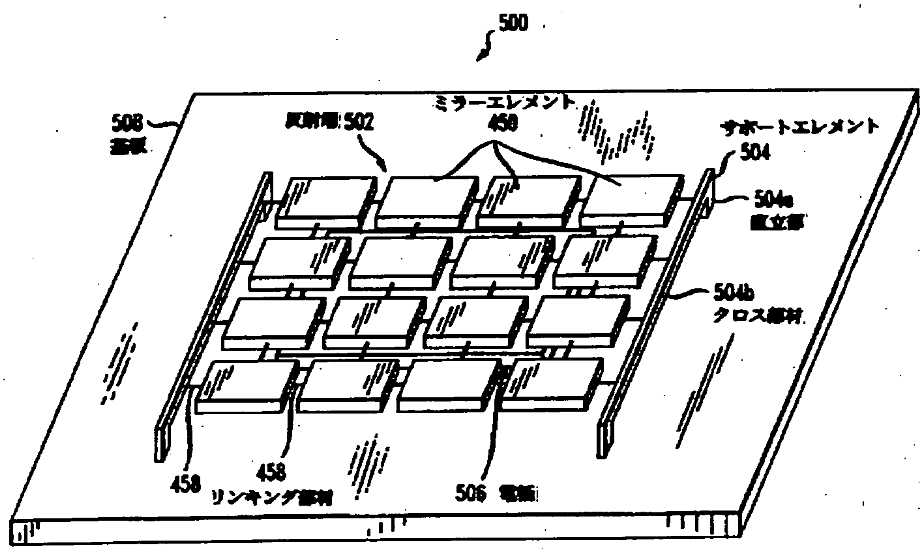


FIG. 4B

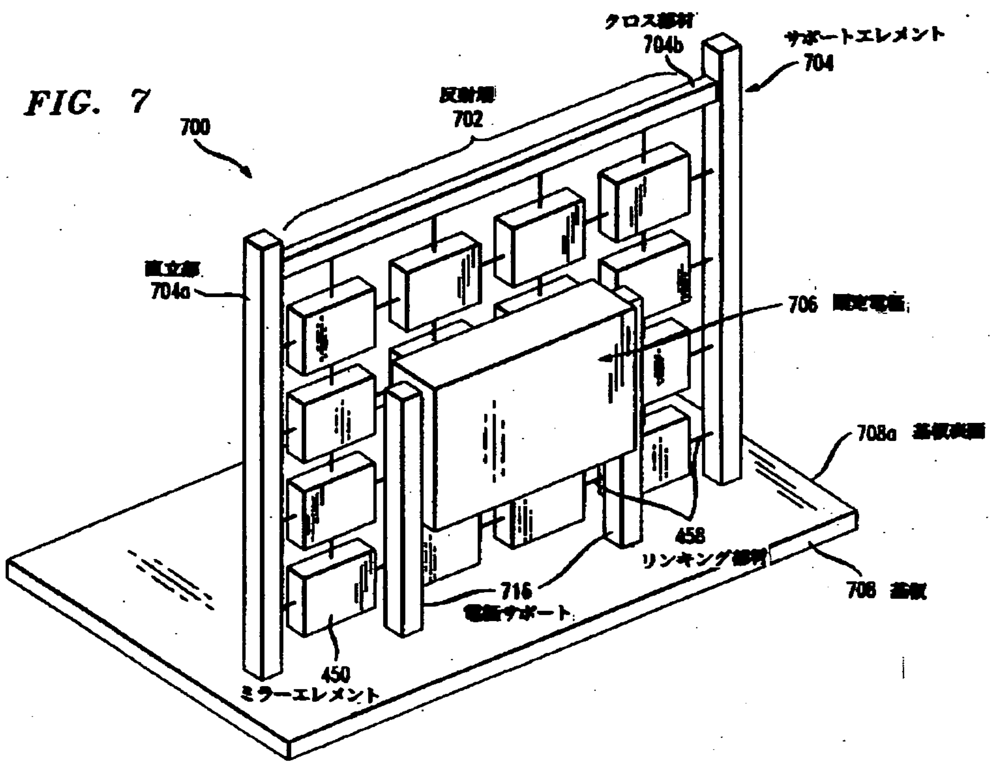


【図6】


500
508
基板
反射層 502
ミラーエレメント
458
サポートエレメント
504
504a
直立部
504b
クロス部材
458
458
リンキング部材
506 電極

【図7】

FIG. 7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反射層
702
クロス部材
704b
サポートエレメント
704
直立部
704a
706 固定電極
708a 基板表面
458
リンキング部材
708 基板
716
電極サポート
450
ミラーエレメント

フロントページの続き

(71)出願人 596077259
600 Ｍｏｕｎｔａｉｎ Ａｖｅｎｕｅ，Ｍｕｒｒａｙ Ｈｉｌｌ， Ｎｅｗ Ｊｅｒｓｅｙ 07974－0636Ｕ．Ｓ．Ａ．

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【外国語明細書】

1. Title of Invention

System And Method For Controlling The Selectivity Of A Holographic Memory System

2. Claims

1. A phase correlation multiplexing (PCM) holographic memory system (HMS), said system comprising:

a holographic memory cell (HMC) having holographic data stored therein;

a holographic optical element (HOE) having stored therein a hologram of a HMS reference beam having a predetermined frequency spectrum;

an object beam source for generating an object beam and for directing said object beam toward said holographic memory cell;

a plane wave source for generating a plane wave signal and for directing said plane wave signal toward said HOE; and

a filter, located between said plane wave source and said HOE, for manipulating said plane wave signal, wherein, upon illumination of said HOE by said manipulated plane wave signal, said HOE projects a modified HMS reference beam toward said holographic memory cell.

2. The system of claim 1, wherein said filter obscures a part of said plane wave signal.

3. The system of claim 2, wherein said filter removes high-frequency components of said plane wave signal.

4. The system of claim 2, wherein said filter comprises a fixed area aperture through which said plane wave signal is directed.

5. The system of claim 2, wherein said filter comprises a variable area aperture through which said plane wave signal is directed.

6. The system of claim 1, wherein said object beam source comprises:

a laser; and

an optical processor through which said laser is directed and from which said object beam emerges.

7. The system of claim 1, wherein said HOE is a transmission-mode HOE.

8. The system of claim 1, wherein said HOE is a reflection-mode HOE.

9. A method of controlling the selectivity of a holographic memory system (HMS) including a holographic memory cell (HMC) having holographic data stored therein, a holographic optical element (HOE) having a hologram of a HMS reference beam stored therein, an object beam source for generating an object beam and for directing the object beam toward the holographic memory cell, a plane wave source for generating a plane wave signal and for directing the plane wave signal toward the HOE, said method comprising the step of manipulating the plane wave signal so that the HOE projects a modified HMS reference beam toward the holographic memory cell upon illumination of the HOE by the manipulated plane wave signal.

10. The method of claim 9, wherein said method comprises the step of obscuring a part of the plane wave signal.

11. The method of claim 9, wherein said method comprises the step of removing a high-frequency component of the plane wave signal.

12. The method of claim 9, wherein said method comprises the step of directing the plane wave signal through a fixed area aperture.

13. The method of claim 9, wherein said method comprises the step of directing the plane wave signal through a variable area aperture.

14. A method of locating a holographic data stored in a holographic storage material having a plurality of holographic data stored therein and used in a holographic memory system (HMS) including a holographic optical element (HOE) having stored therein a hologram of a HMS reference beam, said method comprising the steps of:

(a) directing an object beam toward the holographic storage material; and

(b) manipulating a plane wave signal directed toward the HOE so that, upon illumination of the HOE by the manipulated plane wave signal, the HOE projects a modified HMS reference beam toward the holographic storage material.

15. The method of claim 14, wherein said step (b) comprises obscuring a part of the plane wave signal.

16. The method of claim 14, wherein said step (b) comprises removing high-frequency components of the plane wave signal.

17. The method of claim 14, wherein said step (b) comprises directing the plane wave signal through a fixed area aperture.

18. The method of claim 14, wherein said step (b) comprises directing the plane wave signal through a variable area aperture.

19. A system for locating and retrieving holographic data stored in a holographic storage material, said system comprising:

a holographic optical element (HOE) having stored therein a hologram of reference beam;

a light source for generating a generally collimated light signal and for directing said light signal toward said HOE; and

a filter, located between said plane wave source and said HOE, for manipulating said light signal, wherein, upon illumination of said HOE by said manipulated light signal, said HOE projects a modified reference beam toward said holographic storage material.

20. The system of claim 19, wherein said filter obscures a part of said light signal.

21. The system of claim 20, wherein said filter removes high-frequency components of said light signal.

22. The system of claim 20, wherein said filter comprises a fixed area aperture through which said light signal is directed.

23. The system of claim 20, wherein said filter comprises a variable area aperture through which said light signal is directed.

3. Detailed Description of Invention

Field Of The Invention

The invention relates to holographic memory systems and, more particularly, to a system and method for controlling the selectivity of a holographic memory system.

Background Of Invention

Holographic memory or storage systems involve the three-dimensional storage of holographic representations of data elements (i.e., holograms) as a pattern of varying refractive index and/or absorption imprinted in the volume of a storage medium such as a crystal of lithium niobate. Holographic memory systems (HMS) are characterized by their high density storage potential and the potential speed with which the stored data is randomly accessed and transferred.

In general, holographic memory systems operate by combining a data encoded object beam with a phase coherent reference beam to create an interference pattern throughout a photosensitive storage medium such as a holographic memory cell (HMC). The interference pattern induces material alterations in the HMC that record a hologram. The response of the hologram in the storage medium is a function of the relative amplitudes and polarization states of, and phase differences between, the object beam and the reference beam. It is also highly dependent on the incident beam's wavelengths and angles at which the object beam and the reference beam are projected into the storage medium.

Holographically stored data is reconstructed by projecting a reference beam similar to the reference beam used in storing the data into the HMC at the same angle, wavelength, phase and position used to produce the hologram. The hologram and the reference beam interact to reconstruct the stored object beam (i.e., the data). The

reconstructed object beam may then be detected, e.g., using a photodetector array. The recovered data may then be post-processed for delivery to output devices.

Typically, the dynamic range of the holographic storage medium is larger than what is needed to store a single hologram with an acceptable signal-to-noise ratio. Therefore, it is desirable to multiplex a number of holograms at one location in the storage medium to achieve greater storage density. One multiplexing technique is phase correlation multiplexing (PCM), in which correlation selectivity and Bragg selectivity are used for differentiating overlapping holograms within a storage medium. Correlation selectivity relies on the differences in amplitude, phase and angle content of the reference beam produced by the relative shift (in any direction) of the storage medium with respect to its reference beam.

However, multiplexing schemes such as PCM require relatively complex reference beams whose formation involve complicated phase masks, high quality lenses, and Fourier plane spatial filtering. Unfortunately, the phase masks are delicate in structure, the lenses are expensive and bulky, and the necessary Fourier plane spatial filters block much of the incoming optical energy, greatly increasing the system's power budget. Also, for PCM holographic memory systems, the alignment of these elements is critical down to the micron (μm) level and typically needs to be consistent from system to system. The level of such consistency is often difficult if not impossible to achieve using conventional components and techniques. A holographic optical element (HOE) can be used to generate or reconstruct a reference beam for the holographic memory system. The HOE thus provides a relatively inexpensive, simple and reproducibly consistent replacement for one or more of the optical elements typically required to reproduce a reference beam in a HMS. An exemplary HOE is disclosed in application Serial No. 08/968,024, the entire disclosure of which is incorporated herein by reference.

When using PCM or other correlation selectivity techniques within holographic storage systems, the resulting information stored in the HMC is characterized by relatively high resolution and thus high selectivity. While high resolution and high

selectivity are desirable, and even necessary, for high-density recording of holograms in the HMC, retrieving restored holographic data also requires high resolution and high selectivity techniques and devices.

Therefore, it is desirable to increase the width of the selectivity function of the stored hologram to thereby provide the ability to search for and retrieve stored holographic data more quickly.

Summary Of The Invention

The present invention provides a system and method for controlling the selectivity function in a holographic memory system that permits more rapid location and retrieval of holographically stored data. In accordance with the present invention, a reference beam is directed through a filter such as, for example, an aperture, to bandwidth limit the beam before the beam illuminates a holographic optical element having stored therein a hologram of a reference beam.

The present invention provides a phase correlation multiplexing (PCM) holographic memory system (HMS) that includes a holographic memory cell (HMC) having holographic data stored therein. The PCM holographic memory system also includes a holographic optical element (HOE) having stored therein a hologram of a HMS reference beam having a predetermined frequency spectrum. An object beam source is provided for generating an object beam and for directing the object beam toward the holographic memory cell. A plane wave source is also provided for generating a plane wave signal and for directing the plane wave signal toward the HOE. The PCM holographic memory system also includes a filter, located between the plane wave source and the HOE, for manipulating the plane wave optical field. Upon illumination of the HOE by the manipulated plane wave signal, the HOE projects a modified HMS reference beam toward the holographic memory cell.

The present invention is also directed to a method of controlling the selectivity of a holographic memory system (HMS) including a holographic memory cell (HMC)

having holographic data stored therein. The HMS also includes a holographic optical element (HOE) having a hologram of a HMS reference beam stored therein, an object beam source for generating an object beam and for directing the object beam toward the holographic memory cell, and a plane wave source for generating a plane wave signal and for directing the plane wave signal toward the HOE. The method comprises the step of manipulating the plane wave signal so that the HOE projects a modified HMS reference beam toward the holographic memory cell upon illumination of the HOE by the manipulated plane wave signal.

The present invention is further directed to a method of locating a holographic data stored in a holographic storage material having a plurality of holographic data stored therein and used in a holographic memory system (HMS) including a holographic optical element (HOE) having stored therein a hologram of a HMS reference beam. The method of this embodiment comprises directing an object beam toward the holographic storage material. The method further comprises manipulating a plane wave signal directed toward the HOE so that, upon illumination of the HOE by the manipulated plane wave signal, the HOE projects a modified HMS reference beam toward the holographic storage material.

The present invention is also directed to a system for locating and retrieving holographic data stored in a holographic storage material. The system of this embodiment includes a holographic optical element (HOE) having stored therein a hologram of reference beam. The system further includes a light source for generating a generally collimated light signal and for directing the light signal toward the HOE. The system also includes a filter, located between the light source and the HOE, for manipulating the light signal. Upon illumination of the HOE by the manipulated light signal, the HOE projects a modified reference beam toward the holographic storage material.

Other objects and features of the present invention will become apparent from the following detailed description, considered in conjunction with the accompanying drawing

figures. It is to be understood, however, that the drawings, which are not to scale, are designed solely for the purpose of illustration and not as a definition of the limits of the invention, for which reference should be made to the appended claims.

Brief Description Of The Drawings

In the drawing figures, which are not to scale, and which are merely illustrative, and wherein like reference characters denote similar elements throughout the several views:

FIG. 1 is a schematic diagram of an optical processor for transforming a plane wave signal into an encoded object signal;

FIG. 2 is a schematic diagram of the generation of a transmission-mode holographic optical element for a phase correlation multiplexing holographic memory system;

FIG. 3 is a schematic diagram of the generation of a reflection-mode holographic optical element for a phase correlation multiplexing holographic memory system;

FIGS. 4A-B are schematic diagrams of the use of the holographic optical element of FIG. 2 in a phase correlation multiplexing holographic memory system constructed in accordance with the present invention;

FIGS. 5A-B are schematic diagrams of the use of the holographic optical element of FIG. 3 in a phase correlation multiplexing holographic memory system constructed in accordance with the present invention;

FIG. 6 is a schematic diagram of a holographic memory system constructed in accordance with the present invention;

FIG. 7A is a graphical representation of the selectivity function of a prior art holographic memory system; and

FIG. 7B is a graphical representation of the selectivity function of a holographic memory system constructed in accordance with the present invention.

Detailed Description Of The Presently Preferred Embodiments

One technique for multiplexing a number of holograms to achieve greater storage density in a holographic storage material is phase correlation multiplexing (PCM). Phase correlation multiplexing is disclosed in U.S. Patent No. 5,719,691, the entire disclosure of which is incorporated herein by reference.

As used herein, the term "holographic medium" and "holographic storage material" refer to the actinic material within which a hologram may be recorded. It may take a variety of forms, such as, for example, a film containing dispersed silver halide particles, an acrylate-based photopolymer, or a free-standing $LiNbO_3$ crystal.

As used herein, the term "holographic optical element" (HOE) refers to a defractive optic that may represent one or a plurality of holograms of a reference beam used in the holographic memory system (HMS). A HOE is created, generated, formed, etc. by the interference in the holographic material between a plane wave signal (i.e., a HOE reference beam) and an object beam (i.e., a HMS reference beam). The HOE can be constructed of any material suitable for recording a hologram. Once an HOE is created, the HMS reference beam may be reconstructed by directing a plane wave (i.e., generally collimated light signal) having the same characteristics as the HOE reference beam upon the HOE. The reconstructed reference beam thus provides a means for generating the HMS reference beam without requiring an optical processor. Thus, the HOE provides a single optical element for generating a reference beam that replaces the optical processor, and simplifies how a reference beam is created in a holographic memory system.

As used herein, the term "selectivity" and "selectivity function" refer to the ability of a holographic memory system (or other system for recording and/or retrieving holographic information) to differentiate between a plurality of holographic information

stored in a holographic storage material. The selectivity of a holographic memory system may depend, at least in part, on the bandwidth of a reference signal used to record and retrieve holographic information.

Referring now to FIG. 1, a typical optical processor 135 for use in a phase correlation multiplexing (PCM) holographic memory system (HMS) is shown. The optical processor 135 converts a plane wave signal 105 to an encoded beam that may be used as a reference beam for the HMS (i.e., an HMS reference beam). More specifically, a plane wave signal 105 (i.e., coherent beam of laser light) illuminates a highly structured reference mask 110 (e.g., a phase mask and/or an amplitude mask) that encodes light beam 105, e.g., by inducing a high space bandwidth product on the plane wave signal. The encoded beam propagates a distance *f1* to a first lens 115, which has a focal length *f1*. Passing through first lens 115 produces the Fourier transform of reference phase mask 110 at another distance *f1* beyond first lens 115. A high-pass spatial filter 120 is provided at the plane of the Fourier transform. Filter 120 typically blocks much of the lower spatial frequencies emanating from reference mask 110. After passing through high-pass filter 120, the encoded beam propagates a distance *f2* to a second lens 125, which has a focal length *f2*. The encoded beam passes through second lens 125 and propagates another distance *f2* to reach its image plane 130. At the image plane 130, the encoded beam 140 (labeled A) may be characterized as a reference beam for the holographic memory system (HMS), i.e., a HMS reference beam.

By locating a holographic medium at image plane 130, a hologram of the encoded beam 140 (i.e., a hologram of the HMS reference beam) can be stored in the holographic medium (see, e.g., FIGS. 2 and 3).

The terms "reference beam" and "object beam" are used herein to refer to the beams used in generating a HOE, and to the beams used in the holographic memory system. As such, the different uses of these terms herein will be distinguished by using "HOE" and "HMS", as appropriate.

Referring now to FIG. 2, the generation or formation of a holographic optical element (HOE) 250 for use in a holographic memory system in accordance with the present invention is there depicted. In particular, FIG. 2 depicts the generation of a transmission-mode HOE 250. The HOE object beam 240 (labeled A), which is also the HMS reference beam, is generated as described above with respect to FIG. 1. The HOE object beam 240 propagates or is otherwise directed from the optical processor 235 a distance *D* toward a holographic storage material 252. The HOE object beam 240 impinges upon a holographic storage material 252, where it intersects with a HOE reference beam 260 (a plane wave signal), which is coherent with the HOE object beam 240. The HOE reference beam 260 is generated by a source 264 and is directed therefrom toward the holographic storage material 252 to illuminate the holographic storage material 252 and intersect with the HOE object beam 240 at a predetermined location within the material 252. The resulting interference pattern between the HOE object beam 240 and HOE reference beam 260 is captured as a hologram within the holographic storage material 252, thus transforming the material 252 into a holographic optical element (HOE) 250 having stored therein a hologram of the HOE object beam 240 (i.e., the HMS reference beam).

The HOE reference beam 260 may be any suitable beam, but typically is a plane wave or other beam that is easily reproducible. The HOE object beam 240 and the HOE reference beam 260 typically are generated by coherent light from the same or similar laser source, as is known to persons skilled in the art of holography.

Holographic storage material 252 may be any suitable material or configuration or arrangement of materials that is capable of recording either surface or volume holograms or creating diffracted optics. For example, holographic storage material 252 may be a photopolymer, a photoresist, a thermoplastic material, a photorefractive material or a photochromatic material. Holographic storage material 252 has a generally planar first surface 265 and a generally planar, opposing second surface 270. The material 252 is sufficiently planar or reproducible to approximately two wavelengths of light per centimeter.

Referring next to FIG. 3, the generation or formation of a reflection-mode holographic optical element (HOE) 350 for use in a holographic memory system in accordance with the present invention is there depicted. The HOE 350 depicted in FIG. 3 has a different geometry than the transmission-mode HOE 250 depicted in FIG. 2 and discussed hereinabove. More specifically, a HOE reference beam 360 (beam B) is generated from a source 364 and is directed toward a second surface 370 of holographic storage material 352 to intersect with the HOE object beam 340 (beam A) at a predetermined location within holographic storage material 352. The resulting interference pattern is captured as a hologram of the HOE object beam 340 within holographic storage material 352, thus forming a HOE 350 of the HOE object beam 340. The reflection-mode HOE 350 differs from the transmission-mode HOE 250 in that, *inter alia*, the reflection-mode HOE 350 is generated using beams directed at opposing surfaces of the holographic storage material 352 while the transmission-mode HOE 250 is generated using beams directed at the same surface of the holographic storage material 252.

Both transmission-mode and reflection-mode holographic optical elements (HOE) are capable of storing multiple HOE object beams therein via multiplexing. For example, if the holographic storage material is relatively thick, e.g., 1 millimeter, multiple HOE object beams may be multiplexed in the material to form a HOE of multiple object beams. Multiplexing of the multiple object beams may be accomplished by changing the angle, wavelength or position of the HOE reference beam while changing the object beam characteristics. Changes in the object beam characteristics may include the use of a different mask, filter or lens combination, for example.

Referring now to FIGS. 4A-B, a transmission-mode holographic optical element (HOE) 550 is shown in use in a holographic memory system (HMS) 500 constructed in accordance with the present invention. To reconstruct the HOE object beam 540 (beam A) from the HOE 550, a reference beam 560 identical or similar to the reference beam used to generate the HOE 550 is generated from a source 564 and is directed toward the HOE 550 to illuminate the HOE 550. The beam emanating from the HOE 550 upon

illumination is a reconstruction of the HOE object beam 540 (beam A), which was the object beam originally captured on the holographic storage material 552 to create the HOE 550 and which represent the HMS reference beam. The content and direction of the reference beam 560 with respect to the HOE 550 may depend, at least in part, on the distance *D* between the second lens 525 within the optical processor 535 (see also FIG. 2) and the holographic storage material 252 compared to the focal length *f2* of the second lens during the generation of holographic optical element 550 (e.g., as shown in FIG. 2 and described previously herein).

As shown in FIG. 4A, where the distance *D* during generation of the HOE 550 is less than the focal length *f2* of the second lens (shown previously in FIG. 2), the image plane 575 (labeled P) of the HOE object beam 540 forms beyond the HOE 550. In such cases, the HOE 550 is illuminated by directing the reference beam 560 toward the same surface (i.e., surface 565) as was used to generate the HOE 550. The HOE object beam 540 is then reconstructed by the interaction of reference beam 560 and HOE 550 to form the image plane 575 (or other plane of interest) of the HOE object beam 540 beyond HOE 550.

As shown in FIG. 4B, 550 where the distance *D* during generation of the HOE 550 is greater than the focal length *f2* of the second lens, the image plane 575 (labeled P) of HOE object beam 540 forms before or in front of HOE 550. In such cases, the complex conjugate of reference beam 562 generated from a source 563, is used to illuminate the HOE 550 from a second surface 570, i.e., from the surface opposite that which as was used to generate HOE 550. The complex conjugate of the HOE object beam 542 (labeled A*) is reconstructed by the interaction of the complex conjugate of reference beam 562 and the HOE 550 to form the plane of interest 575 of the complex conjugate of the HOE object beam 542 (A*) before or in front of the HOE 550.

In both embodiments depicted in FIGS. 4A-B, the holographic memory system 500 includes a holographic memory cell (HMC) 580 within which a plurality of holographic data may be stored. The HMC 580 is positioned relative to the image plane

575 for location and retrieval of any of the holographic data stored therein. The holographic data is stored in the HMC 580 as a relatively closely-spaced or densely configured array characterized by a high-degree of selectivity between and among each of the plurality of stored holographic data. For example, a storage density of approximately 300 channel bits/μm^2 is typical in a PCM holographic system.

Referring next to FIGS. 5A-B, a reflection-mode holographic optical element (HOE) 650 is depicted as part of a holographic memory system 600 constructed in accordance with the present invention. The HOE object beam 640 (beam A) is reconstructed by directing a reconstruction reference beam 660 from a source 664 toward and illuminating the HOE 650. The content and direction of the reconstruction reference beam 660 (beam B) with respect to the HOE 650 may depend, at least in part, on the distance *D* between the second lens 625 of the optical processor 635 (see, e.g., also FIG. 3) and holographic storage material 652 as compared to the focal length *f2* of the second lens during the generation of the HOE 650.

As shown in FIG. 5A, where the distance *D* during generation of the HOE 650 is less than the focal length *f2* of the second lens, the image plane 675 (labeled P) of the HOE object beam 640 forms beyond the HOE 650. In such cases, the HOE 650 is illuminated by directing the reference beam 660 toward a second surface 670. Then, similar to previous discussions herein, the HOE object beam 640 is reconstructed by the interaction of the reference beam 660 and the HOE 650 to form image plane 675 (of other plane of interest) of the HOE object beam 640 beyond the HOE 650.

As shown in FIG. 5B, where the distance *D* during generation of the HOE 650 is greater than the focal length *f2* of the second lens, the image plane 675 (labeled P) of the complex conjugate of the HOE object beam 642 (labeled A*) forms in front of or before holographic optical element (HOE) 650. In such cases, the HOE 650 is illuminated by the complex conjugate of the reference beam 662 generated from a source 663. The complex conjugate of the reference beam 662 illuminates the HOE 650 from a first surface 665 opposite that which was used to generate the HOE 650. The complex

conjugate of the HOE object beam 642 (A*) is reconstructed by the interaction of the complex conjugate of the reference beam 662 and the HOE 650 to form an image plane 675 or other plane of interest of the complex conjugate of the HOE object beam 642 (A*) before or in front of the HOE 650.

In both embodiments depicted in FIGS. 5A-B, the holographic memory system 600 includes a holographic memory cell (HMC) 680 within which a plurality of holographic data may be stored. The HMC 680 is positioned relative to the image plane 675 for location and retrieval of any of the holographic data stored therein. The holographic data is stored in the HMC 680 as a relatively closely-spaced or densely configured array characterized by a high-degree of selectivity between and among each of the plurality of stored holographic data.

The above description has been directed to a specific embodiment of a device and method for making a holographic optical element (HOE). This discussion is merely illustrative and provided as a non-limiting example of one such device and method. It will be obvious to persons skilled in the art that other devices and methods of making holographic optical elements may be used in connection with the present invention.

FIGS. 4A-B and 5A-B generally depict the systems and method for recording or storing holographic data in a holographic storage medium in high-density fashion. Referring next to FIG. 6, the location and retrieval of stored holographic data will now be discussed in detail in accordance with the present invention. A holographic memory system 700 includes an optical processor 735 through which a plane wave signal 105 passes and from which an encoded object beam 740 emerges. The object beam 740 includes the desired stored holographic data information. The object beam 740 is directed toward a holographic memory cell (HMC) 780 capable of storing a plurality of holographic data, and having a plurality of holographic data stored therein, including the desired holographic data. A plane wave source 764 generates a generally collimated plane wave signal 765 and directs the plane wave signal 765 toward a HOE 750 that includes a hologram of a holographic memory system (HMS) reference beam 760.

Before reaching the HOE 750, the plane wave signal 765 is manipulated by a filter 790 so that a manipulated plane wave signal 765' illuminates the HOE 750. In the example of an aperture, the filter 790 may comprise a fixed or variable area aperture having a predetermined geometry. The aperture geometry may be, by way of non-limiting example, round, oval, rectangular (i.e., a slit), a bull's eye, or of virtually any other size or shape provided that the aperture modifies the plane wave signal 765 so that the manipulated plane wave signal 765' is different (i.e., in diameter) than the plane wave signal 260, 360 (see, e.g., FIGS. 2 and 3) used to create the HOE 750. The filter 790 preferably removes high-frequency components from the plane wave signal 765, effectively bandwidth limiting the signal 765.

The data originally recorded in the HOE 750 is recorded as a Fourier transform. Consequently, there exists a relationship between the frequency spectrum of the reference beam used to created the HOE (i.e., the HOE reference beam), and where the frequency information is spatially recorded in the HOE 750. Therefore, when the HOE 750 is illuminated by a plane wave signal having a different spatial profile than the HOE reference beam, different stored spectral components of the reference will be illuminated and a modified reference beam 760' will be generated by the HOE 750. The modified reference beam 760' will have a different frequency spectrum than the reference beam used to originally record the hologram in the HOE 750, and will actually have a reduced information content due to the elimination of some high-frequency components. In the example, the modified reference beam 760' will have a broader bandwidth selectivity (see, e.g., FIG. 7B) and the same peak maximum as the original reference beam (see, e.g., FIG. 7A).

The present invention provides for quick location and retrieval of any of the plurality of holographic data stored in a holographic memory cell by increasing the width of the selectivity of the holographic memory system. The spatial frequency spectrum of the reference beam is controlled by directing the beam through a filter 790 that obscures a part of the reference beam so as to remove high-frequency components from the reference beam. The filter 790 manipulates the plane wave signal 765 so that the full-

width at half-maximum of the modified plane wave signal 765' is significantly increased (see, e.g., FIGS. 7A-B). Thus, the reference beam bandwidth is broadened while the peak position is maintained. Consequently, the scan resolution (spatial sensitivity and step resolution of scans) required to located a particular holographic data is significantly reduced. Holographic data can thus be located and retrieved more quickly, resulting in an improvement in the performance of the holographic memory system.

The geometry (i.e., size and shape) of the aperture of the filter will control the spatial frequency spectrum of the beam directed therethrough. In general, as the area of the aperture decreases, causing the diameter of the beam passing therethrough to also decrease, high-frequency components of the beam are attenuated and/or cut-off. The present invention also contemplates a filter that causes the diameter of a light beam passing therethrough to increase. While a few aperture geometries have been discussed herein, the present invention is not limited to such geometries, which are provided by way of non-limiting, illustrative examples.

In general, and as depicted in FIG. 7A, the recording of holograms with a complex reference arm is important to PCM holography and typically results in an extremely narrow selectivity function. Accordingly, extraordinary densities of stored holographic data in a holographic memory cell (e.g., greater than approximately 300 channel bits/μm^2) are possible with phase correlation multiplexing (PCM) holography. For example, the full width at half maximum of the correlation between the reference beam and the stored holographic data is less than approximately 5 μm. The peak value in FIG. 7A represents the diffracted intensity of a stored hologram as a function of HMC position.

Retrieval of stored holographic data has heretofore also required a correspondingly narrow selectivity function. Scanning a holographic memory cell densely populated with a plurality of holographic data for a specific holographic data was time consuming and expensive. The present invention advantageously expands or widens the selectively function of the holographic memory system to permit more rapid

location and reading of holographic data from a holographic memory cell. The graph depicted in FIG. 7B represents the selectivity function of a holographic memory system configured in accordance with the present invention in which the reference beam has been manipulated by a filter as discussed in detail above. Once the desired stored holographic data is located in the holographic memory cell, the stored data may be reconstructed by removing the filter from the one of the reference beam, i.e., by opening the aperture, for example.

Thus, while there have been shown and described and pointed out fundamental novel features of the invention as applied to preferred embodiments thereof, it will be understood that various omissions and substitutions and changes in the form and details of the disclosed invention may be made by those skilled in the art without departing from the spirit of the invention. It is the intention, therefore, to be limited only as indicated by the scope of the claims appended hereto.

4. Brief Description of Drawings

FIG. 1

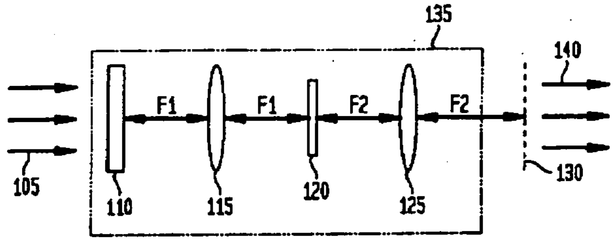


FIG. 2

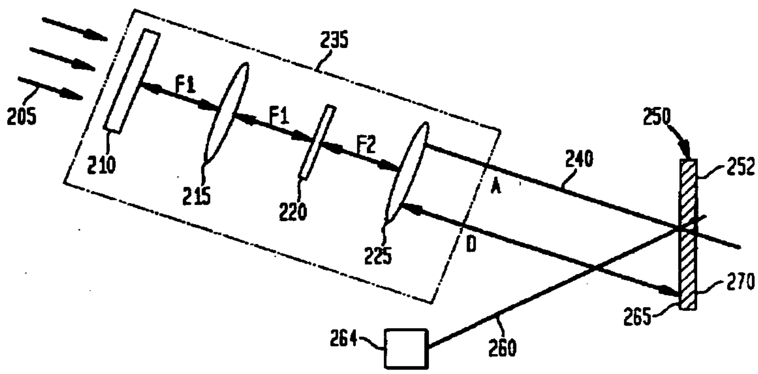


FIG. 3

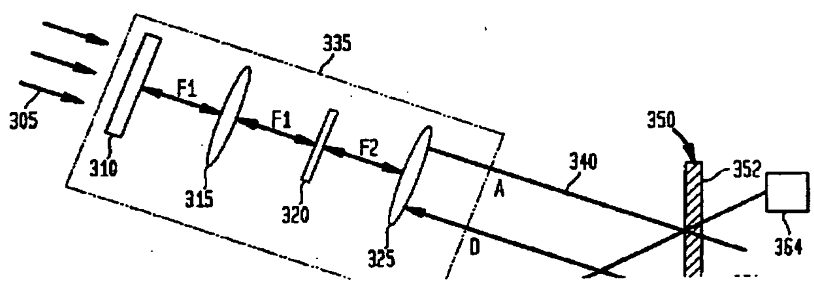


FIG. 4A

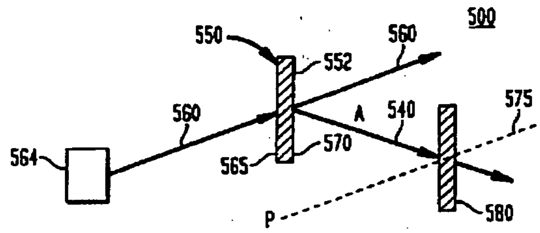
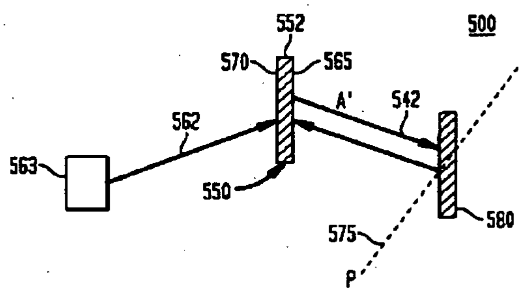

500
550
560
552
575
560
A
540
564
565
570
580
P

FIG. 4B


552
500
570
565
A'
542
562
563
550
580
575
P

3/4

FIG. 5A

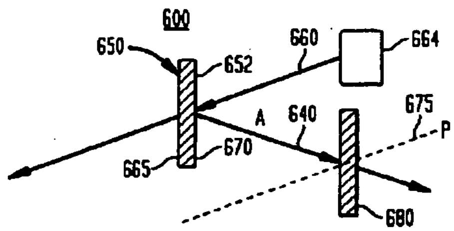


FIG. 5B

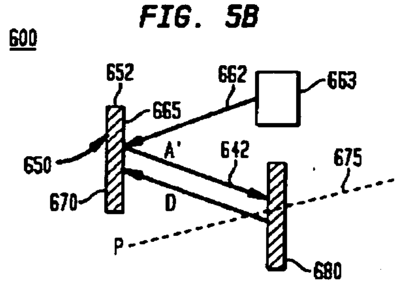


FIG. 6

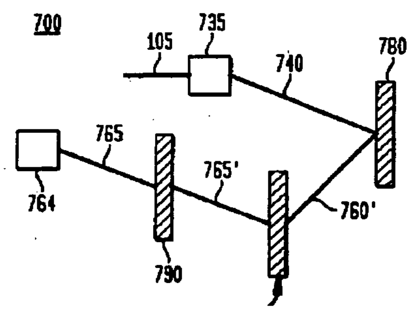


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FIG. 7A

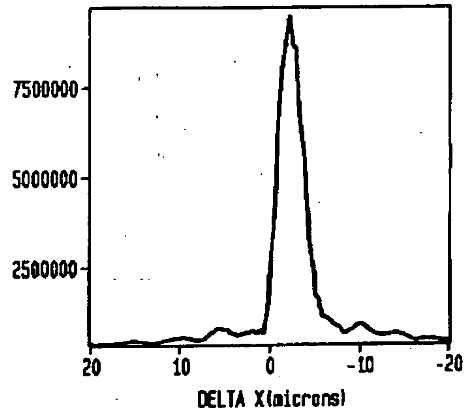
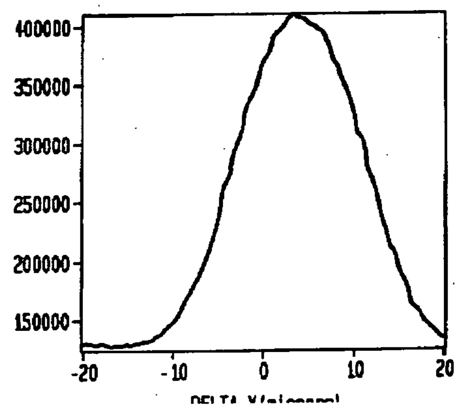


FIG. 7B



1 Abstract

The present invention provides a system and method for controlling the selectivity function in a holographic memory system that permits more rapid location and retrieval of holographically stored data. In accordance with the present invention, a reference beam is directed through a filter such as, for example, an aperture, to bandwidth limit the beam before the beam illuminates a holographic optical element having stored therein a hologram of a reference beam.

2 Representative Drawing

Figure 1

【公報種別】特許法第１７条の２の規定による補正の掲載
【部門区分】第６部門第４区分
【発行日】平成１４年１１月１５日（２００２．１１．１５）

【公開番号】特開２００１－６０３９４（Ｐ２００１－６０３９４Ａ）
【公開日】平成１３年３月６日（２００１．３．６）
【年通号数】公開特許公報１３－６０４
【出願番号】特願２０００－１３０５９１（Ｐ２０００－１３０５９１）
【国際特許分類第７版】
G11C 13/04
G02B 5/32
G03H 1/04
1/22
// G11B 7/0065
【ＦＩ】
G11C 13/04 C
G02B 5/32
G03H 1/04
1/22
G11B 7/0065

【手続補正書】
【提出日】平成１４年８月１３日（２００２．８．１３）
【手続補正１】
【補正対象書類名】明細書
【補正対象項目名】特許請求の範囲
【補正方法】変更
【補正内容】
【特許請求の範囲】
【請求項１】　(a)ホログラフィックデータを記憶して内部に有するホログラフィックメモリセル（ＨＭＣ）と、
(b)所定の周波数スペクトルを有するホログラフィックメモリシステム（ＨＭＳ）参照ビームのホログラムを記憶して内部に有するホログラフィック光学要素（ＨＯＥ）と、
(c)オブジェクトビームを発生し、かつ、前記オブジェクトビームを前記ホログラフィックメモリセルに向けるオブジェクトビーム源と、
(d)平面波信号を発生し、かつ、前記平面波信号を前記ＨＯＥに向ける平面波源と、
(e)前記平面波源と前記ＨＯＥとの間に配置され、前記平面波信号を操作するフィルタとを有し、
前記被操作平面波信号により前記ＨＯＥが照射されたときに、前記ＨＯＥは変更ＨＭＳ参照ビームを前記ホログラフィックメモリセルに向けて投射する、ことを特徴とする位相相関多重化（ＰＣＭ）ホログラフィックメモリシステム。
【請求項２】　前記フィルタは前記平面波信号の一部分を覆い隠す、ことを特徴とする請求項１に記載のシステム。
【請求項３】　前記フィルタは前記平面波信号の高周波数成分を除去する、ことを特徴とする請求項２に記載のシステム。
【請求項４】　前記フィルタは一定面積の開口部からなり、該開口部を通して前記平面波信号が配向される、ことを特徴とする請求項２に記載のシステム。
【請求項５】　前記フィルタは可変面積の開口部からなり、該開口部を通して前記平面波信号が配向される、ことを特徴とする請求項２に記載のシステム。
【請求項６】　前記オブジェクトビーム源は、
(ｲ)レーザと、
(ﾛ)光学プロセッサと
を有し、
該光学プロセッサを通して前記レーザが配向され、かつ、該光学プロセッサから前記オブジェクトビームが出現する、ことを特徴とする請求項１に記載のシステム。
【請求項７】　前記ＨＯＥは透過モードＨＯＥである、ことを特徴とする請求項１に記載のシステム。
【請求項８】　前記ＨＯＥは反射モードＨＯＥである、ことを特徴とする請求項１に記載のシステム。
【請求項９】　ホログラフィックデータを記憶して内部に有するホログラフィックメモリセル（ＨＭＣ）と、ＨＭＳ参照ビームのホログラムを記憶して内部に有するホログラフィック光学要素（ＨＯＥ）と、オブジェクトビームを発生し、かつ、前記オブジェクトビームを前記ホログラフィックメモリセルに向けるオブジェクトビーム

源と、平面波信号を発生し、かつ、前記平面波信号を前記ＨＯＥに向ける平面波源とを有するホログラフィックメモリシステム（ＨＭＳ）の選択性を制御する方法であり、該方法は、
操作された平面波信号により前記ＨＯＥが照明されたときに、前記ＨＯＥが変更ＨＭＳ参照ビームを前記ホログラフィックメモリセルに向けて投射するために、前記平面波信号を操作するステップを有することを特徴とするホログラフィックメモリシステム（ＨＭＳ）の選択性制御方法。

【請求項１０】　内部に記憶された複数のホログラフィックデータを有するホログラフィック記憶材料に記憶され、かつ、ホログラフィックメモリシステム（ＨＭＳ）のホログラムを内部に記憶して有するホログラフィック光学要素（ＨＯＥ）を具備するホログラフィックメモリシステムで使用されるホログラフィックデータの記憶位置を突き止める方法であり、該方法は、
(a)オブジェクトビームを前記ホログラフィック記憶材料に向けるステップと、
(b)操作された平面波信号により前記ＨＯＥが照明されたときに、前記ＨＯＥが変更ＨＭＳ参照ビームを前記ホログラフィック記憶材料に向けて投射するために、前記ＨＯＥに向けられる前記平面波信号を操作するステップとを有することを特徴とするホログラフィックデータの記憶位置突止方法。

【請求項１１】　ホログラフィック記憶材料内に記憶されたホログラフィックデータの記憶位置を突止め、検索するシステムであり、該システムは、
(a)ＨＭＳ参照ビームのホログラムを記憶して内部に有するホログラフィック光学要素（ＨＯＥ）と、
(b)概ね視準された光信号を発生し、かつ、前記光信号を前記ＨＯＥに向ける光源と、
(c)前記光源と前記ＨＯＥとの間に配置され、前記光信号を操作するフィルタとを有し、
前記被操作光信号により前記ＨＯＥが照射されたときに、前記ＨＯＥは変更参照ビームを前記ホログラフィック記憶材料に向けて投射する、ことを特徴とするホログラフィックデータの記憶位置突止・検索システム。